(NEW SERIES)

No. 48

SCIENTIFIC MEMOIRS

BY

OFFICERS OF THE MEDICAL AND SANITARY DEPARTMENTS

OF THE

GOVERNMENT OF INDIA

INVESTIGATIONS INTO THE JAIL DIETARIES OF THE UNITED PROVINCES

WITH SOME OBSERVATIONS ON THE INFLUENCE OF DIETARY ON THE PHYSICAL DEVELOPMENT AND WELL-BEING OF THE PEOPLE OF THE UNITED PROVINCES

BY

MAJOR D. McCAY, M.B., M.R.C.P., I.M.S.
Professor of Physiology, Medical College, Calcutta

ISSUED UNDER THE AUTHORITY OF THE GOVERNMENT OF INDIA BY THE SANITARY COMMISSIONER WITH THE GOVERNMENT OF INDIA

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INVESTIGATIONS INTO THE JAIL DIETARIES OF THE UNITED PROVINCES.

INTRODUCTION.

THE investigations herein recorded have engaged the attention of the staff[1] of the Physiological Department of the Medical College, Calcutta, during all the time that could be spared from official duties. The work began in July 1909, immediately after the conclusion of the investigations on Bengal Jail Dietaries,[2] and has lasted just a year. As in the case of the Bengal Jail Dietaries, the investigations have been carried out on the initiative, and at the expense, of the Sanitary Department of the Government of India.

Owing to the fact that there were no laboratories suitable in the United Provinces the work had to be done in Calcutta. This entailed a considerable amount of travelling as may be judged from the fact that the jail nearest to Calcutta worked in was over 500 miles away, and the most distant over 800 miles from the laboratory.

Historical.

Under this heading in our account of the investigations on Bengal Jail Dietaries we referred to certain important papers on the subject of the dietaries of Indian Jails. In discussing these papers we pointed out the fallacy of assuming that the chemical analysis of food-stuffs afforded a direct measure of their nutritive value. The diet scales laid down for Indian prisons have been worked out from the chemical composition of the available food-stuffs, and for the United Provinces in particular the combinations have been so arranged in the several dietaries as to present a practically constant intake of nitrogen and carbon—the nitrogen not to exceed 282·3 grains nor to be less than 277·8 grains. That is, no account is taken of the source from which the

[1] Four Assistant Surgeons were employed on the enquiry :—
Satis Chandra Banerji, L.M.S., Assistant Professor of Physiology.
Lal Mohan Ghoshal, L.M.S., } Demonstrators, Physiological Department, Medical College, Calcutta.
Madan Mohan Dutta, L.M.S., }
Rajendra Kumar Roy, L.M.S., Attached for duty.

[2] Scientific Memoirs, No. 37.

nitrogen is derived or whether presented in a form easily made use of ; so long as the actual quantity present in a diet comes up to the standard it does not matter seemingly what the source may be. The present inquiry aims at estimations of the percentage absorption of nitrogen shown by the different food-materials and the framing of diet scales based on the knowledge thus obtained, *i.e.*, on their actual nutritive value and not on the gross chemical composition of the food-stuffs available.

We further pointed out that the standards of the diet scales of Indian prisons appear to have been adapted from the dietaries of English Local Prisons, adjusting the quantities of their proximate principles for the difference in weight between English prisoners and Indian prisoners. This method we have shown to be fallacious with regard to the food-stuffs in use in Bengal Jails, and in the present publication, we shall bring forward plenty of evidence to disprove its correctness when applied to the food-stuffs of the United Provinces. We stated that, if the proximate principles of the materials entering into the composition of Indian diets were absorbed in the same proportion as is the case in European diets, this method of framing diets and of calculating their nutritive value would be permissible. But the absorbability of the ultimate alimentary principles of Indian food-stuffs is very far from being identical with that of European food-stuffs, so that, while the gross intake may be identical in the two types of diet, the amount of protein absorbed from each may be very dissimilar. In his Memorandum[1] on the Dietaries of Labouring Prisoners in Indian Jails, Lewis traces the history of the different scales of dietaries for Indian prisons and gives their value in the different alimentary constituents, contrasting them at the same time with the adapted English Local Prisons scales.

In 1877 an Indian Jail Conference, assembled at Calcutta, adopted the following resolution suggesting the introduction of a new scale of dietary for labouring prisoners : —

* * * * * * * * * * * * *

(2) That the following scale be laid down as maximum for adult male prisoners sentenced to hard labour :—

(1) Grain 26 ozs. (including four ozs. pulse) in the form of sifted flour, or 26 ozs. in the case of wheat, rice or barley.

(2) Green vegetables, 6 ozs.

(3) Fatty matter, $1\frac{1}{4}$ ozs.

N.B.—Whenever it may be considered necessary, 4 ozs. meat or fish, or an equivalent of milk, may be given instead of 4 ozs. of grain.

* * * * * * * * * * * * *

[1] A Memorandum on the Dietaries of Labouring Prisoners in Indian Jails. By Surgeon-Major T. R. Lewis, M.B., F.R.S. Annual Report of the Sanitary Commissioner with the Government of India for 1880, page 159.

Lewis states that a comparison of the scales of diet recommended by this Conference with those approved by the Committee of 1864, shows that the main difference consists in the adoption of the principle that the issue of animal food should be left to the discretion of the local jail authorities instead of making it a compulsory article of the labouring and under-trial dietary. In doing this it would seem the Conference was influenced by the satisfactory experience furnished by the jails of the North-Western Provinces and Oudh and also of the Central Provinces, of the dieting of all prisoners without the issue of any animal food whatever.

The diet scales in force in the North-Western Provinces and Oudh—now United Provinces—jails as stated by Lewis appeared to be very much the same as those at present sanctioned in the jail code. From a summary of their nutritive values Lewis observes, "The adapted English scales are, under every heading, considerably smaller than the average nutritive value of the North-Western Provinces' dietaries: the latter may, indeed, be said to be practically identical with the actual English scales. So that if weight have any influence on the food requirements of the body, it may be assumed that the labouring prisoners in these provinces are, weight for weight, considerably better fed than labouring prisoners in England."

The following statement taken from Lewis' Memorandum brings out the points clearly:—

	3 months and under.			Over 3 months.		
	Protein.	Carbo-hydrate.	Fat.	Protein.	Carbo-hydrate.	Fat.
	ozs.	ozs.	ozs.	ozs.	ozs.	ozs.
Average nutritive value of United Provinces diets for labouring prisoners	2·66	16·83	1·08	3·98	19·56	1·16
Average nutritive value of English Local Prison scale . . .	3·13	16·22	1·02	3·91	19·67	1·37
"Adapted" ditto . . .	2·37	12·30	0·77	2·96	14·92	1·04

The jail authorities in those days, as at present, did not limit themselves to the recognised scales but adopted many others in practice. Most of these raised very considerably the intake of the several ingredients, thus making the excess over the adapted English scale even more marked than with the official dietaries.

Thus the chemical analyses of the several diet scales for labouring prisoners in force in the North-Western Provinces and Oudh jails on the average gave a daily value of :—

	3 months and under.	*Over 3 months.*
Nitrogen . .	184 grains.	275 grains.
Carbon . .	4,261 „	5,128 „

While the average intake from diets actually issued to labouring prisoners during 1880 in six District and in six Central jails worked out to be :—

	3 months and under.	*Over 3 months.*
Nitrogen . .	233 grains.	324 grains.
Carbon . .	4,341 „	5,208 „

These figures should be contrasted with the following summarized statement reproduced from Lewis' Memorandum :—

Nutritive value of the principal dietaries at present in force for labouring prisoners in English Jails.

Diet Scales.	Alimentary Principles.			Nutritive value in grains.	
	Protein.	Carbohydrate.	Fat.	Nitrogen.	Carbon.
	ozs.	ozs.	ozs.		
Convict Prisons.					
1. Light labour . . .	3·28	16·25	1·25	226	4,353
2. Industrial labour . . .	3·53	17·09	1·47	243	4,648
3. Hard labour	3·82	18·53	1·52	263	5,013
Local Prisons.					
1. Hard labour, 1—4 months	3·13	16·22	1·02	215	4,232
2. Hard labour, over 4 months .	3·91	19·67	1·37	270	5,204

It will be, therefore, evident that so far as proximate principles are concerned the diet scales of the North-Western Provinces and Oudh are superior to those in force in English prisons. Lewis computed that the nutritive value of the principal maximum scales should be sufficient for prisoners weighing 147, 182 and 164 lbs. judged on the basis of the English Local Prisons standard, *viz.*, 270 grains of nitrogen for a body weight of 145 lbs. Seeing that the average weight of the prisoners in the United Provinces is between 110 and 120 lbs., the scales do appear very excessive. Lewis lays his finger on the weak point, when he states, "That chemical analysis, however exhaustive, can only afford such information as will enable a proximate estimation to be formed of the nutritive value of any food seeing that it is not only what nutriment a particular food-stuff contains, that is of moment, but also what portion of it can

readily be digested and assimilated by the body. In a diet, composed entirely of vegetable substances, the quality of the cooking is of much more importance than it is in animal food dietaries, seeing that a large proportion of nutriment contained in cereals and pulses is enclosed in extremely resistant, indigestible envelopes, which, if not effectually disposed of by proper cooking, defeat all attempts on the part of the digestive organs to profit by the food. In the endeavour which has been manifested by many framers of jail dietaries to raise the proportion of the nitrogenous element without necessitating a corresponding increase in the carbonaceous, a large addition to the pulses has been a favourite mode of meeting the requirements of a view which presupposed the rapid waste of muscle during exercise; but it is questionable whether so large an amount of nitrogenous material does not in reality deteriorate the value of the diet on account of the increased work thrown on the excretory organs in getting rid of a portion of the nitrogenous elements which the system does not require and which, to a certain extent, acts more as an irritant than as a food. In some cases, however, the excess of nitrogenous elements is given in the form of parched, or otherwise imperfectly cooked grain, so that it is probable that a large proportion of the contained nutriment will not be assimilated. On several grounds, therefore, the addition of undue proportion of pulses,—and especially ill-cooked pulses—is a doubtful advantage, and may be even injurious."

We have nothing further to add to this, except to state that the results of all our work in Bengal jails and in the jails of the United Provinces have been to confirm the above opinion expressed by Lewis in 1881, long before any experimental work on the absorbability of the protein of Indian food-stuffs had been done. The chemical composition is of very little value in determining the amount of nitrogen that will be absorbed from the food-stuffs in use in Indian jails, and no reliance can be placed on diets framed on the basis of the gross quantities of proximate principles offered so far as the absorption of nitrogen is concerned. For example, let us take two of the diets officially sanctioned for the jails of the United Provinces, offering an approximately close intake of nitrogen, and contrast the actual result obtained experimentally :—

Diet 1.	Diet 2.
Composed of juar, wheat, arhar dal and vegetables offering 16·79 grms. nitrogen shows 12·748 grms. nitrogen absorbed, or 75·9 per cent. of the nitrogen of the diet.	Composed of wheat, bajra, arhar dal and vegetables offering 16·552 grms. nitrogen shows 10·57 grms. nitrogen absorbed, or 63·8 per cent. of the nitrogen of the diet.

In the experimental work carried out with different food-materials in order to ascertain the percentages of the nitrogen of those food-stuffs undergoing absorption, numerous examples of the same condition will be met with, and ample evidence will be afforded that the amount of nitrogen offered in a diet is no criterion of the level of nitrogenous metabolism attained on that diet.

For this reason alone it is quite impossible to frame diets, composed of Indian food-stuffs, whose chemical composition is similar to those in use in Europe and expect that a similar degree of absorption will take place. It is, therefore, evident that any adaptations from the English prisons scales, as suggested by Lewis, or from the prison dietaries of Scotland, as suggested by Macnamara,[1] are wrong in principle as they make no allowance for the great difference in the absorbability of the nitrogen of European and of Indian food-stuffs.

Further, much of the criticism aimed at the Indian jail dietaries, with a view of showing how excessive they are for prisoners of an average weight of 110 lbs., falls to the ground, as it is mainly based on the fallacy that an equally good absorption will be obtained with Indian as with European food-materials. That absorption from the two classes of food-stuffs is very different and very much to the disadvantage of the Indian, may account for the fact that no action has been taken to reduce the quantities of the food-materials entering into the composition of the Indian dietaries despite several strong recommendations to that effect.

Experience had shown that, while the diets did appear most excessive, lesser quantities had not been satisfactory, or at least that the mortality rate has shown a gradual decrease as the prisoner has been better fed. The decrease in the death rate is probably much more intimately connected with the advances made in Sanitary Science than with the dietary changes during the last 50 years: however, the history of Indian Jail dietaries points to increases in the quantities of the food-materials as a rule to meet some exceptional outbreak of sickness and increase of mortality.

The Scope of the Present Enquiry.

The present investigations deal with the—

(1) Chemical analysis of the food-materials in use in the jails of the United Provinces.

(2) Estimations of the quantities of each proximate principle offered in the several diet scales.

[1] Notes on the Indian Jail Dietaries with special reference to the Punjab. By Major R. J. Macnamara, I.M.S., 1906.

(3) Determinations of the co-efficients of the absorption of the nitrogen of the food-materials in use.

(4) Chemical examination of the excreta.

(5) Determination of the average level of nitrogenous interchange permitted by the jail dietaries.

(6) The suitability of the diet scales at present in force with suggestions for their modification.

(7) The evidence afforded by the physical development of the people on the effects of the level of nitrogenous interchange.

The estimation of the nutritive value of the dietaries and the determination of the co-efficient of the nitrogen absorption of the food-stuffs have again taken up the greater portion of the time that could be spared to the enquiry from official duties. Owing to the composition of the diets in the United Provinces being more or less similar to vegetarian diets in Europe, and owing to the fact that they did not present the huge bulk of the Bengal diets, we had not the same difficulties to contend with as in the work in Bengal. We did not find the bulk interfering as in Bengal, and were therefore able to make use of the ordinary methods of procedure for the determinations of the percentages of nitrogen absorption from the food-stuffs entering into the composition of the dietaries.

The investigations that have been made in Europe and America would appear to show that the food-materials in use in these countries have a high percentage of absorption for the several proximate principles. Thus Rubner and Atwater's[1] figures give :—

Meats, Fish, Milk	91-95% of protein absorbed.
Maize	89% „ „ „
Rice	84% „ „ „
Peas	82½% „ „ „
Beans	70% „ „ „
Whole wheat bread	69½% „ „ „
Potatoes, Cabbagges, Carrots	61-81½% „ „ „

Later figures by Atwater place the average absorption of the protein of legumes at 76% and of cereals from 83-85%.

Of the food-stuffs entering into the composition of the dietaries of the United Provinces, peas, beans, wheat and vegetables are the only materials

[1] Food and the Principles of Dietetics.—R. Hutchison, M.D.

likely to be included in European diets. The results of our investigations show percentages of protein absorption for these food-materials approximately similar to what has been obtained in Europe and America. The food-stuffs peculiar to the dietaries of the United Provinces, on the other hand, show very poor co-efficients of nitrogen absorption. It will be found that few of them exceed 60 per cent., most being between 50 and 60 per cent. What the explanation of this is we are unable to say, but, as suggested by Lewis, in all probability the method of cooking has a considerable influence on the absorption of their nitrogenous constituent.

The results of observations where the diet included considerable amounts of the pulses confirm the opinion expressed by Lewis as to the doubtful advantage of the addition of an undue proportion of pulses to make up dietaries to a given standard of protein intake.

In connection with this work on metabolism there is nothing more striking in observations on the urine and fæces of Europeans and natives of India, respectively, than the low percentage of nitrogen in the urine of the latter as compared with the former, and the small quantity of fæces in the case of the European, giving at most an average of 2 grms. of nitrogen per day compared with the large mass of fæces in the case of the native of India, giving quantities of nitrogen varying from 4 to 7 grms. per day. Later on we shall discuss the framing of suitable dietaries for the jails of the United Provinces, but it will readily be admitted that no diet could be accepted as anything approaching suitable that entailed such waste of precious material as that represented by 6 or 7 grms. of nitrogen daily in the fæces.

The work carried out on the analyses of the excreta includes estimations of the absorption of carbohydrates which we shall discuss later in connection with suitability of the present diet scales. At present all we need say is that the dietaries in the jails of the United Provinces do not present the excessive quantities of carbohydrates which form an outstanding feature of the Bengal Jail dietaries. Neither do we see such manifest signs of intestinal fermentation amongst the prisoners of the United Provinces as met with in the Bengali; so that the loss of potential energy of the dietaries, through the conversion of carbohydrates into carbon dioxide, acetic acid, lactic acid, etc., within the intestinal canal, is probably much less than is the case with prisoners on diets of the Bengal type.

No examination of the absorption of fat was carried out. The amount of fat entering into the composition of the jail dietaries of the United Provinces is very small, only a few grms. being added to that already contained in the food-materials. As fat forms so unimportant an element in the composition of the diets it was not considered necessary to lessen the time that could be

spared to other more important parts of the enquiry, by carrying out numerous investigations of a tedious nature on the fat in the fæces. We shall conclude what we have to say regarding the scope of the present enquiry by giving a short, concise

Account of the work done.

1. All the different food-materials in use in the dietaries of the United Provinces have been analysed. The method adopted was to analyse the food-materials entering into the composition of the dietaries whose nutritive value was being examined. It will be found in the tables giving the results of these analyses that considerable differences were met with in the values of the proximate principles of the same food-material in different jails, or even in the same jail with different samples of the same food-stuff. This is probably due to several different causes such as difference in moisture, degrees of cleanness, state of preservation of the seeds, locality of growth, etc., but the most important element in determining differences in chemical composition appeared to be the degree of contamination with foreign grains. It was practically impossible to get anything approaching pure samples of the different cereals, or even pulses in the different jails visited. A sample of wheat would be found to contain plenty of barley, usually different pulses and millets. Similarly, a sample of arhar dal might contain juar, bajra and other seeds. As the jail authorities make use of second quality of food-stuffs, the materials obtained in jails are never pure. Our analyses present the percentages of proximate principles as found in the jail samples and as actually used by the prisoners, and, except where otherwise stated, are analyses of second quality material or even of a quality more inferior still. This contamination, looked on from one point of view, may not be altogether an unmixed evil, as it may happen that the foreign grain or pulse may have the effect of raising the protein content and also to some extent the co-efficient of nitrogen absorption. Thus, for example, a pure sample of barley would show about 8 per cent. of protein and an absorption of about 54 per cent., while a sample of barley contaminated with wheat may show up to 9·50 per cent. of protein and an absorption of 58 per cent. The draw-back is that wheat, being the most expensive of the food-stuffs in use, contamination of wheat by any of the other materials means a dead loss to the State in cash and a lowering of the nutritive value of the diets to the prisoners.

This part of the work required about

100 Kjeldahl's estimations of nitrogen
60 determinations of carbohydrate
50 determinations of fat.

In all 35 different samples of food-stuffs, obtained from five different jails in the United Provinces, were analysed.

2. Investigations were carried out in the following jails:—

Benares Central jail; Agra Central jail; Naini Central jail, Allahabad; Lucknow Central jail; Mainpuri District jail.

3. The number of prisoners in the different jails who were under observation in the investigations were:—

Benares Central Jail.

18 prisoners under observation for 33 days.
20 „ „ „ „ 16 „
Total 38 prisoners under observation for 49 days.

Agra Central Jail.

30 prisoners under observation for 38 days.
25 „ „ „ „ 14 „
Total 55 prisoners under observation for 52 days.

Naini Central Jail, Allahabad.

20 prisoners under observation for 38 days.
15 „ „ „ „ 16 „
Total 35 prisoners under observation for 54 days.

Lucknow Central Jail.

Total 20 prisoners under observation for 22 days.

Mainpuri District Jail.

Total 20 prisoners under observation for 24 days.

In the investigations on the Jail Dietaries of the United Provinces we had 168 prisoners under observation for over 200 days. During this time the prisoners were isolated, their dietaries arranged, cooked, and distributed by us and their excreta collected for analysis.

4. Chemical analyses—

(*a*) Determinations of the total nitrogen.

1,100 Kjeldahl's determinations of nitrogen in connection with the urine and fæces.

100 Kjeldahl's determination of nitrogen in connection with analyses of food-stuffs.

The estimations of the nitrogen of the urine and fæces were usually done in duplicate, those connected with food analyses were usually in triplicate.

(*b*) The total chlorides were estimated in all samples of urine analysed for total nitrogen, about 300 estimations.

(*c*) Examinations of the fæces for carbohydrates were carried out with 80 samples—the prisoners being on different diets.

Besides this 60 determinations of the carbohydrates of food-stuffs were made and 50 fat estimations.

Methods of work.

5. The methods made use of in the investigations were the same as those found satisfactory in the inquiry on Bengal Jail Dietaries.[1]

(*a*) Analyses of food-stuffs and excreta. The protein estimations were all carried out by Dyer's Modification of Kjeldahl's method, using in addition a few drops of weak solution of phenolphthalein in the cross tube leading from the distillation flask. This re-agent turns red as soon as the ammonia begins to come over and remains red until the last trace has been expelled by the heat, when the colour disappears.

The analyses and estimations of other constituents of the urine, fæces and food-stuffs were carried out by the ordinary methods described in text-books and call for no comment.

(*b*) The method of procedure in carrying out the investigations on prisoners was the same as that followed in the enquiry on Bengal Jail Dietaries.

Batches of healthy picked prisoners—usually five, six or ten men—were isolated during the period of observation. The excreta from the individuals of the batch were pooled, two samples each of the urine and fæces were put up for nitrogen. The procedure with regard to the fæces was as follows:—

The batches of prisoners were put on the diets under investigation for two or three days before any collection of fæces was made. After this interval to accustom them to the diet, a large dose of powdered charcoal was given the first thing in the morning on an empty stomach, the diet to be investigated was then continued for the period—usually six, seven or ten days—when charcoal was again administered. The fæces passed during the period were collected and pooled daily, the pooled fæces were thoroughly mixed by stirring with a large iron spoon for an hour continuously. Then two samples were accurately weighed and put up with strong sulphuric acid in glass-stoppered bottles and packed for transit to the laboratory. We collected the blackened fæces at the beginning of the experiments and left out those blackened at the end of the period: this gave us exactly the fæces

[1] Scientific Memoirs, No. 37.

corresponding with the food taken during the period of observation. An example will make this clear. Supposing an observation had been begun on the first of October by placing a batch of five prisoners on a known diet. They are kept on this diet during the 1st and 2nd of October; on the morning of the 3rd of October each prisoner in the batch is given charcoal, and the same diet continued to the end of the observations. Now on the 4th of October a certain number of the prisoners will pass blackened stools, these will be collected and only these (except any passed after the blackening has disappeared). On the 5th October the remaining prisoners will pass blackened fæces and afterwards uncoloured fæces, all will be collected, mixed, weighed and samples taken. Shortly, at the beginning of the experiment we begin the collection of the fæces with the blackened stools, which correspond with the food taken on the 3rd of October. At the end of the experiment, say on the morning of the 10th October, we again give charcoal: now the process is reversed and the fæces are collected up to the time the blackening begins—the blackened not being included. This method gave very good results in our hands: the prisoners soon learned what was required of them and were able to give a considerable amount of assistance.

The stirring for an hour had the effect of allowing for a great deal of evaporation of moisture, besides mixing the pooled fæces very thoroughly. This permitted us to obtain reliable samples of the pooled material, and the evaporation of moisture made it easier for accuracy in their weighment. On analysis the two samples were found to give practically identical figures for the amount of nitrogen in the stools passed per batch daily.

(*c*) The feeding of the prisoners was carried out on the following plan :—

The food-materials to be used in the complete investigations in a jail were obtained from the store in bulk and kept privately by us. This was necessary in order that the same quality of food-stuffs should be given throughout a series of experiments: so that having found, for instance, the co-efficient of absorption of the nitrogen of the wheat in use at the beginning of a series, we should not discover half-way through that a new consignment of wheat was to be used as the old had been consumed. From our store each day the ration for each man was carefully weighed out; this was cooked in a room or cook-house set apart for our use alone and under the eye of the officer in charge of the feeding of the prisoners. After being cooked the rations were weighed again and then distributed to the prisoners. Anything over was weighed, its value in a dry form calculated and deducted from the total intake. The total value in proximate principles of the daily intake was determined by analyses of the food-stuffs actually used in the experiments.

In the work on the nutritive value of the dietaries of the United Provinces we have relied almost entirely on the accurate determination of the nitrogen intake and the output of nitrogen in the fæces—the difference between these being the amount absorbed and undergoing metabolism. Although the amount of fæces passed by the prisoners in the United Provinces is very large, we did not experience the same difficulty in separating the fæces corresponding to the diet given, as with Bengal prisoners. In Bengal Jails—at least in those where rice, dal, and vegetables form the diet—the prisoners pass exceedingly fluid stools; this was not the case to anything like the same extent in the United Provinces, so that separation of the fæces with charcoal was quite easy.

This concludes all we have to say of an introductory nature, and completes our short sketch of the history of the dietaries in jails of the United Provinces. Before proceeding to give an account of the practical work we desire to offer our best thanks to those officers of the Jail Department in the United Provinces with whom we have come into contact during the investigations.

The Inspector-General of Jails, Lieutenant-Colonel MacTaggart, I.M.S., has assisted us greatly by showing an interest in the work and giving us a free hand in making whatever use of the jails found necessary. The Superintendents of the different jails, where the investigations were carried out, could not have done more to assist us than they did. To them—Lieutenant-Colonel Henderson, Agra; Lieutenant-Colonel Gray, Benares; Major Prawl, Lucknow; Captain R. Steen, Mainpuri, and Captain Palmer, Naini,—we are deeply indebted for their many kindnesses and for their everwillingness to comply with our many demands on their time and energy. Without their active co-operation no possible hope of success could have been entertained.

To the late Lieutenant-Colonel Leslie, C.I.E., I.M.S., Sanitary Commissioner with the Government of India, the originator of the present enquiry, we owe a deep debt of gratitude for valuable advice and assistance not only during the practical investigations but also with the production of the reports connected therewith. His critical examination of the text of our first report and verification of the results as worked out, demand from us complete acknowledgment.

In the production of the present report we have had the able assistance of the Acting Sanitary Commissioner with the Government of India, The Hon'ble Surgeon-General C. P. Lukis, C.S.I., I.M.S., to whom we tender our grateful thanks for a careful and thorough reading and correction of the text.

CHAPTER I.

The Food-Stuffs of the Jail Dietaries of the United Provinces.

The dietaries in force since 1877, and probably earlier, are derived entirely from the vegetable kingdom. The food-materials consist of Wheat, Bajra, Juar, Barley, Makka, Marua, Rice, Gram and the pulses, vegetables and oil.

We extract from the Jail Code the different diet scales laid down for native prisoners, with the notes and explanations attached thereto.

Diet scales for Native Prisoners.

Scale No. I.

Nitrogen, 280. Carbon, 5,268·7.

Days of week.	Cereal pulse combination.	Dal.	Vegetables.	Oil.	Chilli.	Salt.	Firewood.	Antiscorbutic.
	Chtks.	Chtks.	Chtks.	Chtks.	No.	Grains.	Chtks.	
Sunday	14	1	3	$\frac{4}{25}$	1	150	5	From 1st April to 1st November a daily ration of either $\frac{1}{2}$ oz. lime-juice, 70 grains *Amchur*, 70 grains *Putwa*, or 140 grains tamarind pulp should be given.
Monday	14	1	3	$\frac{4}{25}$	1	150	5	
Tuesday	14	1	3	$\frac{4}{25}$	1	150	5	
Wednesday	14	1	3	$\frac{4}{25}$	1	150	5	
Thursday	14	1	3	$\frac{4}{25}$	1	150	5	
Friday	14	1	3	$\frac{4}{25}$	1	150	5	
Saturday	14	1	3	$\frac{4}{25}$	1	150	5	

The 14 chittacks Cereal pulse combination is invariably to be made up according to the subjoined table :—

	Combination letter.	Principal.		Adjuvant.		Total.
		Grain.	Quantity.	Grain.	Quantity.	
	A . .	Wheat .	11 Chittacks	Barley .	3 Chittacks	14 Chittacks.
	B . .	Bajra .	12 „	Pulse .	2 „	14 „
	C . .	Makka .	12 „	„ .	2 „	14 „
Highest Nitrogen 282·3.	D . .	Marua .	11½ „	„ .	2½ „	14 „
Lowest Nitrogen 277·8.	E . .	Wheat .	11½ „	Gram .	2½ „	14 „
Carbon Constant .	F . .	Juar . .	11 „	Pulse .	3 „	14 „
	G . .	Barley .	11 „	Wheat .	3 „	14 „
	H . .	Rice . .	10¼ „	„ .	3¾ „	14 „

Note.—Any two of the above may be combined by taking half of each principal and half of each adjuvant; thus, $\frac{B+C}{2}$ will give Bajra 6 chittacks + Makka 6 chittacks + Pulse 2 chittacks equals 14, or $\frac{A+G}{2}$ will give Wheat 5½ chittacks + Barley 7 + Pulse 1½ =14. If rice is cheap it may be used in the form of bread or boiled as *Khichri*, in either case the combination should be $\frac{A+H}{2}$ that is, Rice 5½ + Wheat 7⅜ + Barley 1½=14. When the Rice is given as *Khichri* the Wheat and Barley are to be given as bread.

Scale No. II.

Nitrogen, 210. Carbon, 4,588·7.

Days of week.	Cereal combination.	Dal.	Vegetables.	Oil.	Chilli.	Salt.	Firewood.	Antiscorbutic.
	Chtks.	Chtks.	Chtks.	Chtks.	No.	Grains.	Chtks.	
Sunday . . .	12	1	3	$\frac{4}{25}$	1	150	5	From 1st April to 1st November a daily ration of either ½ ounce lime-juice, 70 grains *Amchur*, 70 grains *Putwa*, or 140 grains tamarind pulp should be given.
Monday . . .	12	1	3	$\frac{4}{25}$	1	150	5	
Tuesday . . .	12	1	3	$\frac{4}{25}$	1	150	5	
Wednesday . .	12	1	3	$\frac{4}{25}$	1	150	5	
Thursday . .	12	1	3	$\frac{4}{25}$	1	150	5	
Friday . . .	12	1	3	$\frac{4}{25}$	1	150	5	
Saturday . .	12	1	3	$\frac{4}{25}$	1	150	5	

The 12 chittacks Cereal combinations is invariably to be made up according to the subjoined table:—

	Combination letter.	Principal.		Adjuvant.		Total.
		Grain.	Quantity.	Grain.	Quantity.	
	A . .	...	..	...	...	...
	B . .	Bajra .	12 Chittacks	None .	Required .	12 Chittacks.
Highest Nitrogen 210·8.	C . .	Makka .	12 „	„ .	„ .	12 „
Lowest Nitrogen 209·5.	D . .	Marua	8 „	Wheat .	4 Chittacks .	12 „
Carbon Constant .	E . .	Wheat .	12 „	None .	Required .	12 „
	F .	Juar .	7 „	Wheat .	5 Chittacks	12 „
	G . .	Barley .	7 „	„ .	5 „ .	12 „
	H .	Rice . .	6½ „	„ .	5½ „	12 „

Note.—Any two of the above may be combined as in the case of scale No. I. With regard to combination "H" the rice and wheat may be baked together as bread or the rice may be given as *Khichri* and the wheat as bread.

Scale No. III.

Nitrogen, 180. Carbon, 3,908·7.

Days of week.	Cereal combination.	Dal.	Vegetables.	Oil.	Chilli.	Salt.	Firewood.	Antiscorbutic.
	Chtks.	Chtks.	Chtks.	Chtks.	No.	Grains.	Chtks.	
Sunday . . .	10	1	3	$\frac{4}{25}$	1	150	5	From 1st April to 1st November a daily ration of either ½ ounce lime-juice, 70 grains *Amchur*, 70 grains *Putwa*, or 140 grains tamarind pulp should be given.
Monday . . .	10	1	3	$\frac{4}{25}$	1	150	5	
Tuesday . . .	10	1	3	$\frac{4}{25}$	1	150	5	
Wednesday . .	10	1	3	$\frac{4}{25}$	1	150	5	
Thursday . .	10	1	3	$\frac{4}{25}$	1	150	5	
Friday . . .	10	1	3	$\frac{4}{25}$	1	150	5	
Saturday . .	10	1	3	$\frac{4}{25}$	1	150	5	

The 10 chittacks Cereal combination is invariably to be made up according to the subjoined table :—

	Combination letter.	Principal.		Adjuvant.		Total.
		Grain.	Quantity.	Grain.	Quantity.	
	A .	...	...	...	...	...
	B . .	Bajra .	10 Chittacks.	None .	Required .	10 Chittacks.
	C . .	Makka .	10 „	„ . .	„ .	10 „
Highest Nitrogen 128·8.	D . .	Marua .	8 „	Wheat .	2 Chittacks	10 „
Lowest Nitrogen 179·5.	E . .	Juar .	7 „	„ .	3 „	10 „
Carbon Constant.	F . .	Wheat .	10 „	None .	Required .	10 „
	G . .	Barley .	7 „	Wheat .	3 Chittacks	10 „
	H . .	Rice . .	5½ „	„ .	4½ „	10 „

Note.—Any two of the above may be combined as in the case of scale No. I, with regard to letter "H" the rice and wheat may be baked together as bread, or the rice may be given as *Khichri* and the wheat as bread.

N.B.—The wheat used is to be of second quality or "red" wheat.

Only good succulent and nutritious vegetables to be issued, all stalks and midribs being excluded. Oil, mustard, only is to be issued, flavoured with fried onion when given with the dal. For all labouring prisoners and for all prisoners under-trial, the allowance of oil is 4 chittacks to each mess of 25 prisoners.

Diet scale for Native sick Prisoners.

Number of diet.	Gram.	Wheat flour.	Rice.	Dal.	Vegetables.	Fuel.	Salt.	Chillies.	Milk.	Sugar.	Oil.	Ghi.	Sago.	Remarks.
No.	Ch.	Ch.	Ch.	Ch.	Ch.	Ch.	Grs.	No.	Srs.	Ch.	Ch.	Ch.	Ch.	
1	2	10	...	1	3	6	150	1	...	...	$\frac{4}{25}$	$\frac{1}{12}$	...	
2	...	10	...	1	3	6	150	1	...	...	$\frac{4}{25}$	$\frac{1}{12}$	...	
3	2	8	...	1	3	4	150	1	...	...	$\frac{4}{25}$	$\frac{1}{12}$	...	
4	...	...	6	2	3	4	150	1	..	...	$\frac{4}{25}$	$\frac{1}{12}$	...	
5	...	...	4	...	...	4	...	...	1	1	...	...	...	
6	...	...	...	...	...	2	...	...	1	1	...	...	2	
7	Extras not mentioned in above as Benger's food, meat, etc.													Extras as ordered.

1053.—No efforts should be relaxed in securing as good vegetables as possible from the Jail garden. The antiscorbutic fruits, lime, tamarind and mango, are only to be used as aids in supplying the acids which are deficient in the vegetables procurable in the hot weather and rains.

1054.—Three meals a day should be issued, one in the early morning consisting of two chittacks of flour made into *chapatis*, one at midday consisting of six chittacks of flour made into *chapatis* and one chittack of dal, and one in the evening consisting of six chittacks of flour and three chittacks of vegetables.

1055.—For the purpose of regulating the distribution of the above diet scales, all criminal prisoners should be divided into six classes, as noted below :—

Class 1.—All adult male prisoners sentenced to rigorous imprisonment and all adult female prisoners sentenced to simple imprisonment who elect to labour.

Class 2.—All adult female prisoners sentenced to rigorous imprisonment and all adult female prisoners sentenced to simple imprisonment who elect to labour.

Class 3.—All adult prisoners sentenced to simple imprisonment who do not elect to labour.

Class 4.—All juvenile prisoners not arrived at puberty.

Class 5.—All juvenile prisoners arrived at puberty.

Class 6.—All under-trial prisoners.

Diet scale No. 1.—Prescribes the dietaries of prisoners rated in Class 1.

Diet scale No. 2.—Prescribes the dietary of prisoners rated in Class 2 and Class 5.

Diet scale No. 3.—Prescribes the dietaries of prisoners rated in Class 3, Class 4 and Class 6.

1056.—It is to be understood that in any case in which the Medical Officer of a jail considers the dietary prescribed for the class to which a prisoner belongs unsuitable for his health and condition, he is at liberty to order in writing, that the prisoner specified shall be rated with another higher class for a specified period.

In the cases of convalescents or weakly prisoners unable to labour, or performing only the lightest tasks, the diet of non-labouring prisoners, or the labouring diet, reduced by the deduction of the two chittacks of parched grain, may be prescribed at the direction and on the responsibility of the Medical Officer of the prison.

1057.—The flour should be slowly mixed with water and kneaded at the same time, so as to obtain the maximum absorption of water. The cooking should be done slowly and thoroughly, the *táwá* being kept at a gentle heat.

1058.—The quality of the vegetables is of the utmost importance ; all hard stalks and midribs should be excluded, and only good succulent vegetables issued.

1059.—The Superintendent himself shall see at office daily the vegetables ready cut up to the amount required, and shall see that they are freed from all stalks and midribs and other woody portions.

1060.—The quantity of vegetables and the number of chillies in the diet may be increased at the discretion of the Medical Officer, provided they are cultivated by prisoners in the Jail Garden.

1061.—Between the 1st April and the 1st November when the supply of antiscorbutic vegetables is very indifferent, provision should be made for the daily issue of an allowance of lime-juice, tamarind pulp, or *amchur* to each prisoner.

1062.—Lime-juice should be given in the proportion of half an ounce of juice or a single lime (if preserved in oil) to each prisoner.

1063.—Where Superintendents find the full diet too much for a prisoner's digestion during the rains, they should arrange to give a morning meal, thus subdividing the full ration into three meals within 12 hours instead of two meals within six hours.

1064.—Tamarind pulp should be issued in the proportion of half an ounce to each prisoner, mixed up with the daily allowance of salt and chilli; so as to form *chatni*.

1065.—*Amchur* (dried green mango fruit) should be given in the proportion of 70 grains daily to each prisoner, mixed usually with the dal.

1066.—It is to be distinctly understood that tamarind pulp and *amchur* are only to be stored for issue in case of the garden being unable to supply sufficient limes.

1067.—The penal dietary for native prisoners shall be 8 chittacks of wheat flour made into bread or porridge, with the usual quantity of salt and as much water as the prisoner may desire. As in the case of European prisoners, the use of this dietary is limited to 96 consecutive hours.

1070.—From experiment it is found that the weight of the cooked ration should be as under :—

Flour.	Weight when dry.	Weight when cooked.
Wheaten Flour	10 Chittacks .	16 Chittacks.
Barley Flour	10 „ .	16 „
Wheat ½	10 „ .	16 „
Barley ½		

Flour.	Weight when dry.	Weight when cooked.
Wheat $\frac{3}{4}$	10 Chittacks .	16 Chittacks.
Gram $\frac{1}{4}$		
Bajra Flour	12 „ .	$16\frac{1}{2}$ „
Juar Flour	12 „ .	$16\frac{1}{2}$ „
Makka Flour	12 „ .	19 „
Gram Flour (can hardly be cooked alone)	10 „ .	15 „

1071.—If two chittacks of gram flour be added to each ration in lieu of the issue of parched gram, the rations should weigh a little less than three chittacks more than the above scale. There is little appreciable difference in the weight of bread cooked in the oven and on the *táwá*. There is also little appreciable loss in weight by drying from the time the bread is cooked till it is distributed.

1072.—When barley flour is used in the dietary, it must be kept in mind that there is an inevitable loss of six or seven seers per maund in grinding it. Unlike the bran of wheat, the husk of barley is absolutely useless as food, and unless the ground barley is freed from bran to the amount above stated, the prisoners are deprived of so much of their diet.

1074.—The selection of the prisoner cooks shall be made by the Superintendent of the prison, due regard being had to the caste of the men so employed.

1075.—Children under two confined along with their mothers should have a diet allowance as under :—

(*a*) To nursing mothers two chittacks of wheat atta and half a chittack of ghi in excess of the ordinary labouring rations ;

(*b*) to children between 12 and 18 months, six chittacks of milk, two chittacks of rice and half a chittack of dal ;

(*c*) to children between 18 and 24 months four chittacks of milk, four chittacks of rice, and half a chittack of dal.

This should be supplied in two or three meals, as may seem necessary, and the milk should be drawn from the cow at the jail gate, in presence of a superior official of the prison.

(*d*) In the cases of children under 12 months, when the milk of the nursing mother is scanty, it may be supplemented with cow's milk mixed with one-third of water at the discretion of the Medical Officer of the Prison.

1076.—Lime orchards containing at least one full-bearing tree of *Khaghzi* or the Maltése variety for every prisoner, according to the capacity of the jail, should be established in every jail, with a margin to meet contingencies.

1078.—When the tamarind fruit is fresh, *chatni* made by mixing the pulp with the daily ration of salt should be given to the prisoners, or to all who wish for it. An infusion of the fresh fruit might also be given. From October to April the fresh fruit is available and from April till the fruit again ripens, there is no difficulty in preserving it in earthen *Matkas* in a dry store-room.

1079.—If the supply of lime-juice has been exhausted or is insufficient, dried green mangoes, known in the bazar as *amchur*, should be substituted as an antiscorbutic from the 1st of April to the 1st of November in each year.

1080.—When *amchur* is substituted for lime-juice the standard daily allowance per prisoner should be 70 grains.

1081.—The *amchur* requires little or no preparation, it is cut up into thin pieces and allowed to soak in water for some hours; the whole is then added to the dal and vegetables when being cooked. To secure the solution of all the acid, it would be well to have the *amchur* cut up the evening before it is to be used and soaked all night in a sufficient quantity of water in an earthenware vessel.

1082.—The dried fleshy calyces of the *putwa* or roselle (*Hibiscus Sabdariffa*) having been proved from analysis to possess a real and substantial value as an antiscorbutic it should be used in the same proportion as *amchur*, and alternately fortnightly with lime-juice, tamarind and *amchur*, so that the use of any one of them may not become monotonous and distasteful.

The Food-Materials.

Wheat (*Triticum Vulgare*) is the most important of all the food-materials used in the United Provinces. In wheat we get the closest approach in the percentages of its proximate principles to the ratio of nitrogen to carbon essential for a suitable diet. The chemical analyses of the wheat in use in the different jails show greater variation than any other of the food-materials.[1] This is practically entirely due to the different degrees of contamination with

[1] In this connection Church states: "The composition of wheat-grain shows some variations, but they are almost entirely limited to the relative proportions of starch and of nitrogenous matters, although the mineral matters or ash, and indeed all the minor constituents of the grain are, of course, not quite fixed in amount." His analyses of protein show variations ranging from 10·3 to 16·7 per cent.

"The value of Indian wheats in European markets is often much lowered by preventable impurities. Very frequently they contain other cereals, especially barley; gram and linseed sometimes occur in them, and they are often largely contaminated with sand and earth. Then often, two or more kinds of wheat are found mixed together—hard wheat with soft, and red wheat with white." (Food-Grains of India).

"The methods of employing wheat for human food in India vary somewhat, but the following are used to a considerable extent. The grain having been separated from the chaff, often rather imperfectly, is washed, sun-

other grains, most of the samples in ordinary use were of second class quality and contained a large proportion of foreign grains.

The wheat ata or flour of the dietaries is prepared from the whole grain by grinding with small hand-driven grinding stones, and it was quite noticeable in a sample of the ata how much of the outer envelopes of the wheat and contaminating seeds—particularly barley—that remained.

Wheat is grown in the winter months, usually after a rain's crop in the preceding year so that the land lies fallow for about eleven months, or for six months if the previous crop included *arhar*. It is sown at the end of October or the beginning of November and harvested in March and April. It occupies about 18 per cent. of the cropped area of the Provinces, the average annual yield being about two million tons. There is usually a fair amount over requirements for export. In the year ending 1909 about 70,000 tons were exported.[1]

Bajra (*Pennisetum Typhoideum*) is a large millet, sown when the rains break and harvested in November. It occupies about 6 per cent. of the total cropped area of the Provinces, yielding about 500,000 tons.

Barley (*Hordeum Vulgare*) is usually grown mixed with gram or peas, and occasionally with wheat. When grown alone or mixed with wheat the rotation is commonly the same as with the latter crop, but when grown with pulses it frequently follows a rain's crop grown in the same year. Altogether it occupies about 10 per cent. of the crop area of the Provinces, yielding roughly about 2 million tons. Barley alone or even in admixtures is generally thought to be rather difficult of digestion, at least in the form in which the grain is prepared for food in India.[2]

Juar (*Andropogon Sorghum* or *Sorghum Vulgare*) is a high growing millet, sown when the rains break and harvested in November. It usually follows wheat or some other winter crop, and is seldom grown alone except for fodder. The usual mixtures are *arhar* with some of the creeping pulses. It occupies about 6 per cent. of the cropped area of the Provinces, yielding about

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dried and then ground between millstones into meal. The finest part or suji, the second grade or maida, and the coarsest or ata, are respectively used as follows:—

Suji and maida are employed chiefly in the making of confectionery, while the ata is made into unleavened bread or biscuits, usually in the form of flat cakes called chapatti or roti."

"A mixture of wheaten and barley flour is employed in some districts for making the chapatti. Fermented bread is, generally speaking, unknown in India, but is eaten both by Hindus and Moslems, especially by the rich and middle classes in the principal towns of Patna and Behar. It should be mentioned here that scorbutic affections do not occur where wheat is a considerable or almost exclusive article of the daily dietary, a fact in marked contrast with the results observed in districts where rice is very largely consumed" (Church).

[1] Imperial Gazetteer of India, Vol. XXIV and Annual Report on the Inland Trade of the United Provinces, 1909.

[2] Food-Grains of India: Church.

700,000 tons. Juar is one of the most important rainy-season crops of India, forming with rice and wheat the chief staple foods of the country, especially in the United Provinces and Bengal. It is more palatable but less wholesome than maize.[1]

Makka or Maize (*Zea Mays*) is one of the earliest rain crops. It is grown almost after any winter crop and is usually followed by a winter crop in the same year. It occupies nearly 5 per cent. of the cropped area of the Provinces, yielding under one million tons.

Marua or Mandua (*Eleusine Coracana*) is one of the small millets grown in the rains, with the object of replenishing the food-store at the earliest possible moment; it matures about the end of August. Marua is the principal food-crop of large tracts in the Himalayas.

Gram (*Cicer Arietinum*) is grown in the winter, either alone or mixed with barley. It frequently follows rice or an early autumn crop in the same year. It occupies about 13 per cent. of the cropped area of the Provinces, yielding about two and a quarter million tons.

Rice (*Oryza Sativa*) is grown during the rains, mostly in low-lying heavy clays. The crop is grown year after year on the same land, but a winter pulse is frequently taken in the interval between two rice crops. Rice occupies 14 per cent. of the cropped area of the Provinces, yielding over three million tons.

The creeping pulses *mung* (Phaseolus Mungo), *urid, urd* or *mash* (Phaseolus radiatus) are, as a rule, grown with juar and bajra.

The winter pulses, besides gram, are peas, *masur* and *kisari*. *Masur* or lentil (*Ervum Lens*) is grown mainly in the damper parts of the Provinces, usually after autumn rice.

The prices of food-grains vary considerably; the following may be taken as a fair average of the normal rates:—

Price per rupee in seers of 80 tolas.[2]

Wheat	12·1
Barley	17·9
Rice (common)	7·9
Bajra	16·8
Gram	15·8
Juar	17·2
Arhar	9·4
Maize	16·4

[1] Food-Grains of India: Church.
[2] Annual Report on the Inland Trade of the United Provinces, 1909.

The price will vary with the quality of the material supplied, but the above figures show the relative expense of wheat and barley, *arhar* and gram, and the gain to the supplier of a judicious admixture of these pairs or in other ways. However, as we have seen the different food-materials are often grown with one another and are thus mixed from the beginning.

The ordinary vegetables in season are used in the jails. Each jail has a well-managed vegetable garden so that good vegetables are always to be had. We accepted the 6 ozs. of vegetables given in the jail dietaries and made no variation in this amount.

The following tables give the percentage composition in proximate principles of the samples of food-materials received from the different jails. Special precautions were taken to get accurate results for the protein content, each sample being analysed three or more times.

In Table F we have given the average composition of all the food-materials obtained from the different jails where investigations were carried out, with their heat value in calories per ounce calculated from the percentage composition of the proximate principles, and also as determined experimentally from the food-stuffs.

For the experimental determination of the heat value of the several food-materials we are again indebted to Professor Benedict of the Carnegie Institute, Washington, U.S.A., for which we tender him our sincere thanks.

Chemical Analyses of Food-stuffs of the Jails of the United Provinces.

TABLE A.

Central Jail, Agra.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Wheat (best quality obtained.)	Protein	10·75	10·83	10·95	10·64	...	10·79
	Carbohydrate	71·40	72·60	71·80	...	...	71·90
	Fat	1·50	1·72	...	...	...	1·61
Wheat (ordinary jail sample).	Protein	10·06	9·93	10·00	10·12	...	10·03
	Carbohydrate	70·40	72·80	70·50	...	...	71·20
	Fat	1·72	1·83	1·50	1·25	1·30	1·52
Juar— Sample (1)	Protein	7·98	7·84	7·88	...	...	7·90
	Carbohydrate	67·14	67·38	...	...	...	67·26
	Fat	...	...	...	...	...	...

TABLE A.—*continued.*

Central Jail, Agra—continued.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Sample (2)	Protein	7·37	7·62	7·56	...	...	7·52
	Carbohydrate	...	...	...	...	...	...
	Fat	2·69	2·86	...	...	...	2·77
Gram	Protein	16·71	17·00	17·05	17·00	17·00	16·95
	Carbohydrate	48·40	49·60	...	...	...	49·00
	Fat	4·69	4·53	...	...	...	4·60
Arhar Dal— Sample (1)	Protein	21·51	21·62	21·84	21·34	...	21·58
	Carbohydrate	53·80	54·20	53·60	...	...	53·86
	Fat	...	...	...	...	...	..
Sample (2)	Protein	22·06	22·12	...	...	...	22·09
	Carbohydrate	...	...	...	...	...	...
	Fat	1·79	2·03	...	...	...	1·91
Urid Dal	Protein	23·37	23·18	22·87	23·06	...	23·12
	Carbohydrate	...	...	...	...	...	...
	Fat	1·90	2·00	...	...	...	1·95

Table B.

Central Jail, Naini.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Wheat . . .	Protein . .	10·38	10·30	10·25	10·44	...	10·34
Urid Dal . . .	Protein . .	22·00	21·87	...	...	...	21·93
Bajra	Protein .	8·70	8·83	...	...	...	8·72
	Carbohydrate	72·60	73·80	...	...	...	73·20
Gram—							
Dal (1) . .	Protein .	16·35	16·62	...	...	...	16·49
„ (2) . .	Protein .	17·68	17·95	...	...	...	17·82

Table C.

Central Jail, Benares.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Wheat (1st class) . .	Protein .	11·86	11·80	12·12	12·04	11·98	11·98
	Carbohydrate	72·60	73·4	73·10	...	...	73·03
	Fat .	1·57	1·57	...	...	...	1·57
Wheat (ordinary jail sample).	Protein .	11·02	10·78	10·84	...	...	10·88
	Carbohydrate	...	...	...	...	...	...
	Fat . .	1·32	1 25	...	...	...	1·29
Gram	Protein .	19·45	19·53	...	...	...	19·49
	Fat . .	5·10	5·80	...	...	...	5·45
Bajra	Protein .	8·16	8·72	...	...	...	8·67
	Fat . .	4·89	4·73	4·89	4·53	...	4·76
Juar	Protein .	6·95	7·18	6·99	7·04	...	7·04
	Fat . .	2 69	2·79	...	...	...	2·74
Barley . . .	Protein .	8·14	8·27	8·24	...	...	8·22
	Carbohydrate	76·40	75·80	...	...	...	76·10
	Fat . .	1·86	1·86	1·92	1·96	...	1·90

Table D.

Central Jail, Lucknow.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Wheat—							
Sample (1)	Protein	9·81	9·79	9·75	...	...	9·78
	Carbohydrate	73·40	74·10	...	...	...	73·75
	Fat	1·69	1·59	...	...	...	1·64
Sample (2)	Protein	9·68	9·72	9·61	...	...	9·67
Barley	Protein	9·87	9·50	9·81	9·68	...	9·72
	Fat	1·92	1·86	1·93	1·87	...	1·89
Juar	Protein	8·25	8·18	...	...	...	8·22
	Fat	2·83	2·76	...	...	...	2·80
Gram (1)	Protein	20·68	20·75	...	...	...	20·72
„ (2)	Protein	20·06	20·08	...	...	...	20·07
„ (3)	Protein	18·40	18·60	...	...	...	18·50
	Fat	4·83	5·16	4·89	4·95	...	4·96
Arhar Dal (1)	Protein	22·36	22·15	...	...	...	22·26
	Fat	1·75	1·80	1·70	1·86	...	1·78
„ „ (2)	Protein	20·75	21·81	20·86	...	...	21·14

Table E.

District Jail, Mainpuri.

Food-stuffs.	Proximate principles.	Number of analyses carried out.					Average percentage composition.
		1	2	3	4	5	
Wheat	Protein	10·38	10·30	10·25	10·44	...	10·34
Bajra	Protein	8·70	8·83	..	...	...	8·77
	Carbohydrate	73·60	73·70	...	...	...	73·65
Urid Dal	Protein	22·00	21·87	...	...	...	21·94
Gram— Dal (1)	Protein	16·35	16·62	...	...	...	16·49
	Carbohydrate	55·56	54·88	...	...	...	55·22
„ (2)	Protein	17·68	17·95	...	...	...	17·82
	Carbohydrate	51·80	52·4	...	...	...	52·10
	Fat	4·62	4·85	...	...	...	4·74

Table F.

Average Composition of Food-materials examined.

Food-stuffs.	Protein.	Carbohydrate.	Fat.	Heat value per oz. calculated.	Heat value per oz. obtained by experiment.
Wheat, 1st class . . .	11·98	73·03	1·57	102·97	111·56
Wheat, Jail	10·17	72·48	1·51	99 82	110·25
Juar	7·67	67·26	2·77	94·72	110·97
Gram Dal	18·32	50·55	4·94	93·10	118·20
Arhar Dal	21·77	53·86	1·85	92·79	113·63
Urid Dal	22·33	55·22	1·95	95·28	113·09
Bajra	8·72	73·40	4·76	108·04	...
Barley	8·92	76·10	1·90	103·79	106·40

The following are the results of the work done on the determination of the moisture and heat values carried out by Professor Benedict of the Carnegie Institute, Washington, U.S.A.

Food-stuff.	Water in partially dried substance.	Heat of Combustion	
		of food-stuffs as received with the given per cent. H_2O.	of water-free substance.
	Per cent.	Calories per grm.	Calories per grm.
Barley, Benares Jail	16·61	3·532	4·236
Arhar Dal „ „	13·34	3·925	4·529
Juar „ „	11·13	3·913	4·403
Gram Dal „ „	9·89	4·297	4·769
Wheat, Naini Jail	10·83	3·910	4·385
Gram Dal „ „	10·19	4·033	4·491
Urid „ „	10·67	3·935	4·405
Wheat, Lucknow Jail	11·48	3·849	4·348
Barley „ „	10·32	3·972	4·429
Arhar Dal „ „	8·70	4·089	4·479
Gram „ „ „	10·12	4·248	4·726
Wheat, Agra Jail	10·06	3·915	4·353
Urid Dal „ „	10·45	4·017	4·486
Gram „ „ „	9·69	4·097	4·537
Wheat, 1st class Lucknow Jail . . .	11·16	3·934	4·428

CHAPTER II.

The Values of the Dietaries of the Jails of the United Provinces in proximate principles.

We have given the tables, extracted from the United Provinces' Jail Code, showing the different diets sanctioned for prisoners. The dietaries are different for different classes of prisoners, but it will do all we require if we study the maximum diets laid down for adult labouring prisoners. These diets consist in a cereal pulse combination of 14 chittacks with 1 chittack of dal, 3 chittacks of vegetables, $\frac{4}{2\frac{1}{5}}$ of a chittack of oil, etc., the cereal pulse combination to be made up according to a fixed scale. These diets are supposed to have been so arranged as to offer in each a practically identical amount of nitrogen and carbon, which indicates the principle on which the diets have been founded, *viz.*, to arrange the several food-stuffs in such relative quantities that a certain standard of nitrogen and carbon intake shall be maintained. The Jail Code states that this standard should be 280 grains of nitrogen and 5268·7 grains of carbon.

We shall have to discuss the suitability of these diets in the light of the experimental work carried out to ascertain the respective degrees of nitrogen absorption shown by the food-stuffs entering into them; at present we shall rest content with drawing attention to the fact that, in the framing of these scales, no attention was paid to the differences in absorbability of protein presented by the several food-materials. One food-stuff was looked upon as being as good as another so long as the respective quantities of each were so arranged that identical amounts of carbon and nitrogen were provided for in the dietaries. Thus it seems that the different food-materials appear to be able to replace each other if only the quantities be so arranged that the proper standard be maintained. As would be expected this is by no means the case, the absorption of the most important element—protein—of the several food-materials is not identical; so that, while several diets composed of different food-stuffs can be arranged to offer practically identical quantities of protein, the level of nitrogenous interchange may be very different with the respective diets. This we shall show to be the case. The protein of the different food-materials will be shown to vary considerably in the percentage absorbed, so that the protein of one food-stuff cannot be substituted for that of another, and therefore one food-stuff cannot be substituted for another, on the principle of offering identical quantities, without serious changes being brought about in the level of nitrogenous absorption and in the nutritive value of the diet. Therefore dietaries framed on this method are wrong in principle, as it deals entirely with the gross intake

instead of attaching greater importance to the value of the food-stuffs as nutriments, that is, on the amount of absorption possible from them. It is the aim of the present investigation to appraise the different food-materials at their proper value, as indicated by the ease with which their most important constituents are absorbed.

We shall now take up the several dietaries in force from the standpoint of the gross quantities of the several constituents they offer.

The dietaries are as follows :—

Diet.	Principal.		Adjuvant.		Dal.	Vegetables.	Oil.
A	Wheat	11 Chittacks	Barley	3 Chittacks	1 Chittack.	3 Chittacks.	$\frac{4}{25}$ Chittack.
B	Bajra	12 „	Pulse	2 „	1 „	3 „	$\frac{4}{25}$ „
C	Makka	12 „	„	2 „	1 „	3 „	$\frac{4}{25}$ „
D	Marua	$11\frac{1}{2}$ „	„	$2\frac{1}{2}$ „	1 „	3 „	$\frac{4}{25}$ „
E	Wheat	$11\frac{1}{2}$ „	Gram	$2\frac{1}{2}$ „	1 „	3 „	$\frac{4}{25}$ „
F	Juar	11 „	Pulse	3 „	1 „	3 „	$\frac{4}{25}$ „
G	Barley	11 „	Wheat	3 „	1 „	3 „	$\frac{4}{25}$ „
H	Rice	$10\frac{1}{4}$ „	„	$3\frac{3}{4}$ „	1 „	3 „	$\frac{4}{25}$ „

Note—Any two of the above may be combined by taking half of each principal and half of each adjuvant, the other items, dal, vegetables, oil, remaining constant.

Diet A.

	Wheat.	Barley.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein .	65·05	15·55	12·65	3·12	...	96·97
Carbohydrate	463·65	132·71	31·31	25·50	...	653·17
Fat . .	9·60	3·30	1·07	1·58	9·08	24·63

Salt 10 grammes per man daily.

Heat value in calories 3,300

Diet B.

	Bajra.	Pulse.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein . .	60·86	25·96	12·65	3·12	...	102·59
Carbohydrate .	512·04	64·10	31·31	25·50	..	632·95
Fat . .	33·22	2·24	1 07	1·58	9·08	47·19

Salt 10 grammes per man daily.

Heat value in calories 3,450

Diet C.

	Makka.	Pulse.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein .	66·62*	25·96	12·65	3·12	...	108·35
Carbohydrate .	461·84	64·10	31·31	25·50	...	582·75
Fat . .	16·04	2·24	1·07	1·58	9·08	30·01

Salt 10 grammes per man daily.

Heat value in calories 3,112

Diet D.

This diet is never given, so far as we could find out, in the jails of the United Provinces and we have made no analysis of marua, from which to work out its value.

Diet E.

	Wheat.	Gram.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein . .	67·98	26·60	12·65	3·12	..	110·35
Carbohydrate .	484·48	73·39	31·31	25·50	...	614·68
Fat . .	10·09	7·17	1·07	1·58	9·08	28·99

Salt 10 grammes per man daily.

Heat value in calories 3,242

* This figure is based on analyses of maize carried out in Bengal from samples obtained from Bengal jails. It is probably higher than would have been the case if the maize had been obtained in the United Provinces. However, as this diet is never used in the jails of the United Provinces and as we made no experiments with it, it is introduced here only for reference.

Diet F.

	Juar.	Pulse.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein . .	49·04	38·94	12·65	3·12	...	103·75
Carbohydrate .	430·32	96·30	31·31	25·50	...	583·43
Fat . . .	17·71	3·36	1·07	1·58	9·08	32·80

Salt 10 grammes per man daily.

Heat value in calories 3,122

Diet G.

	Barley.	Wheat.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein . .	57·04	17·74	12·65	3·12	...	90·55
Carbohydrate .	486·65	126·45	31·31	25·50	...	669·91
Fat . . .	12·15	2·62	1·07	1·58	9·08	26·50

Salt 10 grammes per man daily.

Heat value in calories 3,364

Diet H.

	Rice.*	Wheat.	Dal.	Vegetables.	Oil.	Total proximate principles.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Protein . .	40·85	22·17	12·65	3·12	...	78·79
Carbohydrate .	469·59	158·05	31·31	25·50	...	684·45
Fat . . .	5·12	3·27	1·07	1·58	9·08	20·12

Salt 10 grammes per man daily.

Heat value in calories 3,316

These are the different diets sanctioned for use in the jails of the United Provinces. As will be seen from the columns giving the total proximate

* The percentage composition of rice has been taken as being the same as found for Bengal Jails. As rice is never used in the jails of the United Provinces, we made no analysis of this food-stuff. It is introduced here only for reference.

principles, the actual analyses of the diets do not give quantities so identical as supposed to be the case. Thus :—

Diet A.

Protein	96·97 grms.	Heat value 3,300 calories.
Carbohydrate	653·17 „	
Fat	24·63 „	

Diet B.

Protein	102·59 grms.	Heat value 3,450 calories.
Carbohydrate	632·95 „	
Fat	47·19 „	

Diet C.

Protein	108 35 grms.	Heat value 3,122 calories.
Carbohydrate	582·75 „	
Fat	30·01 „	

Diet E.

Protein	110·35 grms.	Heat value 3,242 calories.
Carbohydrate	614·68 „	
Fat	28·99 „	

Diet F.

Protein	103·75 grms.	Heat value 3,122 calories.
Carbohydrate	583·43 „	
Fat	32·80 „	

Diet G.

Protein	90·55 grms.	Heat value 3,364 calories.
Carbohydrate	669·91 „	
Fat	26·50 „	

Diet H.

Protein	78·79 grms.	Heat value 3,316 calories.
Carbohydrate	684·45 „	
Fat	20·12 „	

So that, with regard to the most important constituent, protein, we get quantities varying from 78·79 grms. to 110·35 grms., the claim, therefore, that these diets offer identical quantities of nitrogen can hardly be substantiated; neither are the quantities of carbon presented in the several diets similar in the amount.

The supposed protein value of these diets in the Jail Code is 280 grains of nitrogen, which would mean about 115 grms. of protein. None of the diets work out to be so high from analysis of the food-stuffs actually in use. The factors, therefore, that have been employed in calculating the values have been those that would be correct for first class food-materials, but which

are too high for the food-materials used in the jails of the United Provinces at the present time.

Our calculated values of the different diets in proximate principles are based on the average composition of the food-materials analysed and as shown on table "F." We may, therefore, accept the figures representing their values as being fair averages of the diets as consumed by the prisoners. Any variation from these values will depend largely on the quality and pureness of the food-stuffs obtained for consumption.

The apparent value of these diets.

It will be evident to anyone conversant with the standards of dietaries that those of the jails of the United Provinces, offering over 100 grammes of protein and over 650 grammes of carbohydrates are by no means illiberal; but that, on the contrary, for prisoners of an average weight of 110 to 115 lbs. the diets are in reality generous. To quote Lewis again, "The adapted English scales are, under every heading, considerably smaller than the average nutritive value of the North-Western Provinces' dietaries; the latter may, indeed, be said to be practically identical with the actual English scales. So that, if weight have influence on the food requirements of the body, it may be assumed that the labouring prisoners in these Provinces are, weight for weight, considerably better fed than labouring prisoners in England." He computes the average maximum diet to be sufficient for prisoners weighing 164 lbs. as compared with the average weight of prisoners in the United Provinces of 110—115 lbs. With Lewis' opinion we entirely agree; there is not the slightest doubt but that the dietaries are most liberal both in nitrogenous material and in the potential energy. Calculated according to the accepted heat equivalents the average fuel value is 3,280 calories, which is higher than that of any of the standard diets that have been formulated for Europeans. This heat value of the dietaries offers over 60 calories per kilo. of body weight, the usually accepted standard being 40 or slightly over 40 calories.

We shall show, however, that the defects of most of these diets are such as to lessen their nutritive value to a very serious extent, with the result that while, according to their chemical composition, they appear to be superior to the English Prison scales and even to most of the standard dietaries, in reality they are much inferior. The explanation for this will be found to be the low degree of protein absorption shown by the food-stuffs entering into the composition of the dietaries of the jails of the United Provinces.

We shall now proceed to give an account of the experimental work carried out to determine the protein absorption from the different dietaries in force and the average level of nitrogenous interchange attained by the prisoners throughout the year.

CHAPTER III.

The average amount of Nitrogen absorbed from the Jail Dietaries of the United Provinces.

The diet scales for adult native prisoners on hard labour consist of 14 chittacks of a cereal pulse combination, 1 chittack of dal, 3 chittacks of vegetables with salt, a little oil and chilli. The cereal pulse combination is invariably made up according to the subjoined table :—

Combination Diet.	Principal.		Adjuvant.		Total.
	Grain.	Quantity.	Grain.	Quantity.	
A . . .	Wheat . .	11 Chittacks.	Barley . .	3 Chittacks	14 Chittacks.
B . . .	Bajra . .	12 „	Pulse . .	2 „	14 „
C . . .	Makka . .	12 „	Do. . .	2 „	14 „
D . . .	Marua . .	11½ „	Do. .	2½ „	14 „
E . . .	Wheat . .	11½ „	Gram . .	2½ „	14 „
F . . .	Juar . .	11 „	Pulse . .	3 „	14 „
G . . .	Barley . .	11 „	Wheat . .	3 „	14 „
H . . .	Rice .	10¼ „	Do. . .	3¾ „	14 „

Any two of the above may be combined by taking half of each principal and half of each adjuvant; thus, $\frac{B+C}{2}$ will give Bajra 6 chittacks + Makka 6 chittacks + Pulse 2 chittacks = 14, or $\frac{A+G}{2}$ will give Wheat 5½ chittacks + Barley 7 chittacks + Pulse 1½ Chittacks = 14.

Note.—1 chittack = 2·05 ozs., but for ordinary purposes may be taken as equal to 2 ozs.

These are the official diet scales as sanctioned in the Jail Code, but in practice they are to a large extent ignored. The only diet commonly in use is Diet E of the above table; in fact it is the only one given in the majority of the jails all over the Province. During the cold weather months juar, bajra and barley are sometimes made use of, but hardly ever in the quantities laid down. The different Superintendents give their own combinations of these food-stuffs with wheat and pulse, which are usually very different from the diets officially sanctioned.

Rice has been very rarely used in the United Provinces. As it is only grown to a limited extent, the price is prohibitive. It was, however, some years ago used in two district jails, close to the borders of Bengal, but an

outbreak of Beri-Beri in both of these caused it to be discontinued and its use has never been revived.

Marua is never given at all; in fact, we failed to obtain samples even for analysis from the different jails, where investigations were carried out.

Makka or Indian corn or maize is seldom, if ever, used; why this is so we do not understand as it is a very nutritious food-material and certainly superior to some of those in use.

The pulses made use of in the United Provinces are principally *arhar dal* and *urid dal*. It would appear from the above table that gram *dal* is not classed as a pulse, but this is a mistake as gram *dal* belongs to the pulses.

For at least nine months in the year Diet E., *i.e.*—

Wheat	11½	chittacks.
Gram	2½	„
Arhar dal	1	chittack.
Vegetables	3	chittacks.
Salt	150	grains.
Oil	9·08	grms.
Condiments	1	chittack.

is given to the exclusion of all others. We have, therefore, first of all to find out what is the average level of nitrogenous interchange attained on such a diet. On proceeding to investigate this diet and to obtain the level of nitrogenous metabolism permitted by it in the different jails of the province we were quickly forced to the conclusion that very different quantities of nitrogen were absorbed and metabolised on what appeared to be the same diet. For, while the same food-materials gave identical results in any one jail, this diet gave different results in the several jails where investigations were carried out. It was observed that the further north-west we went the lower became the level of nitrogenous interchange; the highest results were obtained with the food-materials grown in Benares and Allahabad districts and the lowest with those grown in Lucknow and Agra districts.

The explanation of this was not difficult to find. It will be seen on reference to the analyses of the food-stuffs of the principal jails that the protein content of the food-materials, but especially wheat, is higher in the first-named districts than in the latter, and mere inspection of the samples was all that was necessary in order to solve the problem. Wheat, sold as such and indeed as grown, is not by any means a pure sample of wheat, but a mixture, to a greater or lesser degree, of wheat and barley with other grains. All but the barley are fairly easily got rid of in cleaning, the barley remaining even in well-cleaned samples. The degree of admixture with barley varies in different parts of the

Province but is very much higher in the samples obtained from Agra and Lucknow than in those from Allahabad and Benares. As we shall show later the percentage of nitrogen of barley that undergoes absorption is very much lower than that of the nitrogen of a pure sample of wheat, it will be evident that any admixture of barley with wheat will have the effect of lowering the percentage of nitrogenous absorption of that sample. Thus, we found that the percentage absorption of the nitrogen of the wheat in use in Benares and Allahabad differed considerably from what was the case in Lucknow and Agra, and therefore the level of nitrogenous interchange on Diet E varied in these several jails.

Similarly, as we shall have occasion to point out when dealing with diets into which barley enters, the fact that a pure sample of barley—without some admixture of wheat—is almost impossible to obtain, and more difficult in Agra and Lucknow districts than in Allahabad and Benares, means that the percentage of the protein content of barley is higher than it should really be, and higher in Agra and Lucknow experiments than in those carried out in Allahabad and Benares.

We shall now proceed to give the results of the investigations carried out to obtain the average level of nitrogenous interchanges attained on the United Provinces jail dietaries. The food-stuffs in use during these investigations were as far as possible the ordinary materials: it is probable, however, that in some cases the food-materials were of better quality than those usually in stock. Four large Central jails were selected, roughly situated in the north, south, east and west of the Province and fairly well covering the different tribes and races inhabiting the United Provinces.

Batches of picked men were isolated, placed on the weighed out diet for a number of days, the urine and fæces being carefully collected—the fæces for the period being separated with charcoal—and analysed in the usual way. The food-stuffs made use of during the observations were also analysed. In this way we obtained the daily intake of nitrogen in the dietaries and the daily output of nitrogen in the fæces and were thus in a position to ascertain the average level of nitrogen undergoing metabolism with the different diets.

A.—Diet E.

Wheat	11½	chittacks	or	23	ozs. roughly.
Gram dal	2½	„	„	5	„
Arhar	1	chittack	„	2	„
Vegetables	3	chittacks	„	6	„

Oil, condiments, salt, etc., as usual.

(1) Benares Jail.

Serial Number 1. Batch A.

Five prisoners under observation for six days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th February 1910 .	4·39	17·98	11·174	4·111	1·95	0·5
19th February 1910 .	4·57	20·90	11·174	4·111	1·95	0·5
20th February 1910 .	4·56	20·62	11·174	4·111	1·95	0·5
21st February 1910 .	7·32	32·68	11·174	4·111	1·95	0·5
22nd February 1910 .	5·51	24·42	11·174	4·111	1·95	0·5
23rd February 1910 .	8·51	32 82	11·174	4·111	1·95	0·5
24th February 1910 .	3·86	16·72	11·174	4·111	1·95	0·5

[Except where otherwise mentioned the figures in these tables with reference to weights are grammes.]

Charcoal was given in the morning of the 17th February 1910 and again on the morning of the 23rd February 1910.

Average intake of nitrogen per man daily . . . 17·735 grms.

Average output of nitrogen in fæces per man daily . 5·538 grms.

Nitrogen absorbed—12·197 grms.=68·7 per cent. of nitrogen of diet.

Serial No. 2. Batch A.

Six prisoners under observation for six days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
3rd January 1910 .	9	196·668 grms.	11·174	4·111	1·95	0·5
4th January 1910 .	5		11·174	4·111	1·95	0·5
5th January 1910 .	4·5		11·174	4·111	1·95	0·5
6th January 1910 .	5·5		11·174	4·111	1·95	0·5
7th January 1910 .	5·5		11·174	4·111	1·95	0·5
8th January 1910 .	4·2		11·174	4·111	1·95	0·5
9th January 1910 .	4·75		11·174	4·111	1·95	0·5

Average intake of nitrogen per man daily . . . 17·735 grms.

Average output of nitrogen in fæces per man daily . . 5·463 grms.

Nitrogen absorbed—12·272 grms. =69·2 per cent. of nitrogen of diet.

Therefore, the ordinary jail diet in Benares Jail shows an average absorption of 12·2345 grms. of nitrogen =68·99 per cent. absorbed.

(2) Naini Jail, Allahabad.

Serial No. 3. Batch A.

Five prisoners under observation for five days.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
16th February 1910 .	...	...	...	...	...	...
17th February 1910 .	64·32	26·17	10·833	3·7705	1·90	0·5
18th February 1910 .	104·55	29·62	10·833	3·7705	1·90	0·5
19th February 1910 .	90·20	22·53	10·833	3·7705	1·90	0·5
20th February 1910	98·40	22·63	10·833	3·7705	1·90	0·5
21st February 1910 .	91·22	23·79	10·833	3·7705	1·90	0·5

Average intake of nitrogen per man daily . . . 17·0035 grms.

Average output of nitrogen in fæces per man daily . . 4·9898 grms.

Nitrogen absorbed—12·0139 grms.=70·6 per cent. of nitrogen of diet.

Serial No. 4. Batch A.

Ten prisoners under observation for ten days.

From 2nd December 1909 to 12th December 1909.

Average intake of nitrogen per man daily . . . 17·0035 grms.

Average output of nitrogen in fæces per man daily . . 5·054 grms.

Nitrogen absorbed—11·9495 grms.=70·2 per cent. of nitrogen of diet.

Therefore, the ordinary jail diet in Naini Jail shows an average absorption of 11·9817 grms. of nitrogen=70·4 per cent. of the nitrogen of the diet.

(3) Lucknow Jail.

Serial No. 5. Batch B.

Five prisoners under observation for five days.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
17th March 1910 .	94·0	20·52	10·028	4·197	1·9184	0·5
18th March 1910 .	97·5	21·76	10·028	4·197	1·9184	0·5
19th March 1910 .	117·0	26·87	10·028	4·197	1·9184	0·5
20th March 1910 .	119·0	24·63	10·028	4·197	1·9184	0·5
21st March 1910 .	93·5	20·41	10·028	4·197	1·9184	0·5
22nd March 1910 .	43·0	14·39	10·028	4·197	1·9184	0·5

Average intake of nitrogen per man daily . . . 16·6434 grms.

Average output of nitrogen in fæces per man daily . . 5·1432 grms.

Nitrogen absorbed—11·5002 grms. =69·1 per cent. of nitrogen of diet.

(4) Agra Jail.

Serial Number 6. Batch A.

Ten prisoners under observation for ten days.

From 12th December 1909 to 22nd December 1909.

Average intake of nitrogen per man daily . . . 16·727 grms.

Average output of nitrogen in fæces per man daily . . 5·969 grms.

Nitrogen absorbed—10·758 grms.=64·3 per cent. of nitrogen of diet.

Serial No. 7. Batch A.

Five prisoners under observation for seven days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th March 1910 .	7·25	28·29	10·433	3·855	1·9964	0·5
19th March 1910 .	8·00	28 45	10·433	3·855	1·9964	0·5
20th March 1910 .	9·50	29·87	10·433	3·855	1·9964	0·5
21st March 1910 .	9·50	29·99	10·433	3·855	1·9964	0·5
22nd March 1910 .	7·12	23·06	10·433	3·855	1·9964	0·5
23rd March 1910 .	6·20	22·39	10·433	3·855	1·9964	0·5
24th March 1910 .	9·50	31·20	10·433	3·855	1·9964	0·5
25th March 1910 .	3·38	14·14	10·433	3·855	1·9964	0·5

Average intake of nitrogen per man daily . . . 16·7844 grms.

Average output of nitrogen in fæces per man daily . . 5·9254 grms.

Nitrogen absorbed—10·859 grms.=64·7 per cent. of nitrogen of diet.

Therefore, the ordinary jail diet in Agra Jail shows an absorption of 10·8085 grms. of nitrogen=64·5 per cent. of the nitrogen of the diet.

From these investigations recorded under the serial number 1 to 7 we can obtain the average amount of nitrogen absorbed from Diet E of the Jail Code. Thus:—

1.	Intake .	. 17·7350 grms.	Absorbed .	. 12·1970	grms.
2.	„	. 17·7350 „	„ .	. 12·2720	„
3.	„ .	. 17·0035 „	„ .	. 12·0139	„
4.	„ .	. 17·0035 „	„ .	. 11·9495	„
5.	„ .	. 16·6434 „	„ .	. 11·5002	„
6.	„ .	. 16·7270 „	„ .	. 10·7580	„
7.	„ .	. 16·7844 „	„ .	. 10·8590	„

Therefore, an average intake of 17·09026 grms. shows an absorption of 11·64996 grms. or 68·16 per cent. These observations having been carried out

with the average food-stuffs of different parts of the Province, we may accordingly accept the result as a true measure of the level of nitrogenous interchanges possible on Diet E of the Jail Code, when the ordinary food-materials of the different jails are made use of.

B.—Diet A.

Wheat	11 chittacks or 22 ozs. roughly.
Barley	3 „ „ 6 „ „
Arhar	1 chittack „ 2 „ „
Vegetables	3 chittacks „ 6 „ „

Oil, condiments, salt, etc., as usual.

Mainpuri Jail.

SERIAL NO. 8. BATCH A.

Ten prisoners under observation for six days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
24th October 1909 .	12·00	317·64 grms.	10·0826	2·3412	2·0782	0·5
25th October 1909 .	10·12		10·0826	2·3412	2·0782	0·5
26th October 1909 .	12·00		10·0826	2·3412	2·0782	0·5
27th October 1909 .	13·38		10·0826	2·3412	2·0782	0·5
28th October 1909 .	10·50		10·0826	2·3412	2·0782	0·5
29th October 1909 .	10·50		10·0826	2·3412	2·0782	0·5
30th October 1909 .	10·20		10·0826	2·3412	2·0782	0·5

Average intake of nitrogen per man daily . . . 15·002 grms.

Average output of nitrogen in fæces per man daily . 5·294 grms.

Nitrogen absorbed—9·708 grms.=64·7 per cent. of nitrogen of diet.

Mainpuri Jail is situated fairly close to Agra and the food-stuffs in use were much of the same quality in the two jails. In samples from these jails the wheat contained a large percentage of barley and the barley showed a fair proportion of wheat. As will be evident later this admixture of the two food-materials caused a lowering of the percentage absorption of the nitrogen of wheat and a raising of that of the nitrogen of barley.

C.—Diet G.

Wheat	3 chittacks or 6 ozs. roughly.
Barley	11 „ „ 22 „ „
Arhar	1 chittack „ 2 „ „
Vegetables	3 chittacks „ 6 „ „

(1) Mainpuri Jail.

Serial No. 9. Batch B.

Ten prisoners under observation for six days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
24th October 1909 .	13·45	305·24 grms.	2·7498	8·5844	2·0784	0·5
25th October 1909 .	13·82		2·7498	8·5844	2·0784	0·5
26th October 1909 .	12·45		2·7498	8·5844	2·0784	0·5
27th October 1909 .	13·50		2·7498	8·5844	2·0784	0·5
28th October 1909 .	10·50		2·7498	8·5844	2·0784	0·5
29th October 1909 .	10·00		2·7493	8·5844	2·0784	0·5
30th October 1909 .	3·45		2·7498	8·5844	2·0784	0·5

Average intake of nitrogen per man daily . . . 13·9124 grms.

Average output of nitrogen in fæces per man daily . 5·0874 grms.

Nitrogen absorbed—8·825 grms.=63·4 per cent. of nitrogen of diet.

(2) Lucknow Jail.

Serial No. 10. Batch C.

Five prisoners under observation for six days.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
2nd March 1910 .	71·50	17·84	2·649	9·678	2·0192	0·5
3rd March 1910 .	114·50	26·20	2·649	9·678	2·0192	0·5
4th March 1910 .	104·00	22·90	2·649	9·678	2·0192	0·5
5th March 1910 .	87·50	23·20	2·649	9·678	2·0192	0·5
6th March 1910 .	108·50	30·77	2·649	9·678	2·0192	0·5
7th March 1910 .	94·50	23·37	2·649	9·678	2·0192	0·5
8th March 1910 .	29·00	12·27	2·649	9·678	2·0192	0·5

Average intake of nitrogen per man daily . . . 14·8462 grms.

Average output of nitrogen in fæces per man daily . . 5·2183 grms.

Nitrogen absorbed—9·6279 grms.=64·8 per cent. of nitrogen of diet.

The higher result obtained in Lucknow Jail compared with that from the same diet in Mainpuri Jail is due to the higher percentage of the nitrogen of wheat absorbed and the greater protein content of the barley in use in Lucknow Jail.

D.—Diet F.

Juar	11 chittacks	or 22 ozs.	roughly.
Pulse (Urid dal)	3 „	„ 6 „	„
Arhar	1 chittack	„ 2 „	„
Vegetables	3 chittacks	„ 6 „	„

Agra Jail.

SERIAL NO. 11. BATCH B.

Five prisoners under observation for five days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Juar.	Nitrogen of Urid.	Nitrogen of Arhar.	Nitrogen of Vegetables.
26th March 1910 .	8·00	30·92	7·4844	6·294	1·9964	0·5
27th March 1910 .	12·72	49·27	7·4844	6·294	1·9964	0·5
28th March 1910 .	8·40	34·99	7·4844	6·294	1·9964	0·5
29th March 1910 .	12·28	43·21	7·4844	6·294	1·9964	0·5
30th March 1910 .	6·70	23·50	7·4844	6·294	1·9964	0·5

Average intake of nitrogen per man daily . . 16·2748 grms.

Average output of nitrogen in fæces per man daily . . 7·2756 grms.

Nitrogen absorbed—8·9992 grms. =55·3 per cent. of nitrogen of diet.

It will be noticed that no less than half the total nitrogen of this diet is derived from the pulses, 8 ozs. of Urid and Arhar dal entering into the composition of the diet. This in itself is sufficient to condemn the diet, and as a result we find only 55 per cent. of its nitrogen absorbed. As will be seen later practically 60 per cent. of this diet should be absorbed, so that the excessive quantities of pulse actually tend to decrease the percentage absorption of protein from diets of this type.[1]

E.—Diet B.

Bajra	12 chittacks	or 24 ozs.	roughly.
Pulse (Urid dal)	2 „	„ 4 „	„
Arhar	1 chittack	„ 2 „	„
Vegetables	3 chittacks	„ 6 „	„

[1] Church states, "The digestibility of the albuminoids in pulse as compared with that of the corresponding compounds in the cereals grains has been usually regarded as low. In general, they are not only digested and absorbed at a slower rate, but a larger proportion of the total amount present remains unattacked and unused in its passage through the alimentary canal. The proportion of unused to used albuminoids is proportionately highest when the pulse forms the largest part of the ration; it is much reduced when the pulse constitutes not more than one-fourth of the daily food." [Food-Grains of India.]

Naini Jail.

Serial No. 12. Batch B.

Ten prisoners under observation for ten days.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Bajra.	Nitrogen of Urid.	Nitrogen of Arhar.	Nitrogen of Vegetables.
2nd December 1909 .	11·50	645·08 grms.	9·5289	4·00	1·951	0·5
3rd December 1909 .	15·00		9·5289	4·00	1·951	0·5
4th December 1909 .	17·50		9·5289	4·00	1·951	0·5
5th December 1909 .	15·00		9·5289	4·00	1·951	0·5
6th December 1909 .	14·50		9·5289	4·00	1·951	0·5
7th December 1909 .	13·50		9·5289	4·00	1·951	0·5
8th December 1909 .	13·00		9·5289	4·00	1·951	0·5
9th December 1909 .	14·00		9·5289	4·00	1·951	0·5
10th December 1909 .	10·50		9·5289	4·00	1·951	0·5
11th December 1909 .	12·00		9·5289	4·00	1·951	0·5

Average intake of nitrogen per man daily . . . 15·9799 grms.

Average output of nitrogen in fæces per man daily . . 6·4508 grms.

Nitrogen absorbed—9·5291 grms. = 59·6 per cent. of nitrogen of diet.

F. Diet ½ (E + F).

Wheat	5¾ chittacks	or	11½ ozs. roughly.
Juar	5½ „	„	11 „ „
Gram	2¾ „	„	5½ „ „
Arhar	1 chittack	„	2 „ „
Vegetables	3 chittacks	„	6 „ „

Agra Jail.

Serial No. 13. Batch B.

Ten prisoners under observation for ten days.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
12th October 1909 .	14·75	588·57 grms.	5·2187	3·993	4·2405	1·939	0·5
13th October 1909 .	11·75		5·2187	3·993	4·2405	1·939	0·5
14th October 1909 .	12·25		5·2187	3·993	4·2405	1·939	0·5
15th October 1909 .	8·50		5·2187	3·993	4·2405	1·939	0·5
16th October 1909 .	11·50		5·2187	3·993	4·2405	1·939	0·5
17th October 1909 .	7·25		5·2187	3·993	4·2405	1·939	0·5
18th October 1909 .	10·50		5·2187	3·993	4·2405	1·939	0·5
19th October 1909 .	11·00		5·2187	3·993	4·2405	1·939	0·5
20th October 1909 .	12·75		5·2187	3·993	4·2405	1·939	0·5
21st October 1909 .	9·50		5·2187	3·993	4·2405	1·939	0·5

Average intake of nitrogen per man daily . . . 15·8912 grms.

Average output of nitrogen in fæces per man daily . . 5·8857 grms.

Nitrogen absorbed—10·0055 grms. =62·9 per cent. of the nitrogen of the diet.

These conclude our observations on the dietaries officially sanctioned in the Jail Code. As already stated other combinations than those laid down are made use of in the several jails. Some of these combinations were investigated where the actual quantity of food was kept constant at 18 chittacks including 3 chittacks of vegetables. The results obtained we shall give under the heading G.

G. Diet.

Different combinations of the food-materials making 18 chittacks, the official quantity.

Serial No. 14.

Five prisoners under observation for five days.

Wheat	6 chittacks.
Juar	7 ,,
Arhar	2 ,,
Vegetables	3 ,,

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
17th March 1910 .	69·50	19·97	5·298	5·208	4·0384	0·5
18th March 1910 .	83·50	24·15	5·298	5·208	4·0384	0·5
19th March 1910 .	67·00	20·52	5·298	5·208	4·0384	0·5
20th March 1910 .	75·00	21·51	5·298	5·208	4·0384	0·5
21st March 1910 .	75·00	24·66	5·298	5·203	4·0384	0·5
22nd March 1910 .	29·50	14·05	5·298	5·208	4·0384	0·5

Average intake of nitrogen per man daily . . . 15·0444 grms.

Average output of nitrogen in fæces per man daily . . 4·9944 grms.

Nitrogen absorbed—10·05 grms. = 66·8 per cent. of nitrogen of diet.

Serial No. 15.

Five prisoners under observation for five days.

Wheat	8 chittacks.
Barley	6 „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
10th March 1910 .	72·50	14·70	7·064	5·268	2·0192	0·5
11th March 1910 .	107·50	23·78	7·064	5·268	2·0192	0·5
12th March 1910 .	105·50	23·85	7·064	5·268	2·0192	0·5
13th March 1910 .	112·50	25·65	7·064	5·268	2·0192	0·5
14th March 1910 .	120·50	20·08	7·064	5·268	2·0192	0·5
15th March 1910 .	30·00	8·50	7·064	5·268	2·0192	0·5

Average intake of nitrogen per man daily . . . 14·8512 grms.

Average output of nitrogen in fæces per man daily . 4·6624 grms.

Nitrogen absorbed—10·1888 grms. = 68·6 per cent. of nitrogen of diet.

Serial No. 16.

Five prisoners under observation for seven days.

Wheat	5 chittacks.
Juar	8 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total Nitrogen of Fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
19th January 1910 .	3·11	17·61	5·354	5·110	3·90	0·5
20th January 1910 .	2·36	12·61	5·354	5·110	3·90	0·5
21st January 1910 .	3·92	21·55	5·354	5·110	3·90	0·5
22nd January 1910 .	3·42	19·45	5·354	5·110	3·90	0·5
23rd January 1910 .	5·64	29·83	5·354	5·110	3·90	0·5
24th January 1910 .	4·23	22·43	5·354	5·110	3·90	0·5
25th January 1910 .	3·60	21·56	5·354	5·110	3·90	0·5

Average intake of nitrogen per man daily . . . 14·864 grms.

Average output of nitrogen in fæces per man daily . . 4·144 grms.

Nitrogen absorbed—10·72 grms.=72·1 per cent. of nitrogen of diet.

(Note.—The wheat given in this diet was first class material, so that the absorption is higher than would have been the case if the ordinary jail standard of wheat had been used.)

Serial No. 17.

Ten prisoners under observation for five days.

Wheat	9 chittacks.
Bajra	4 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total nitrogen of Fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
12th January 1910 .	18·00	34·06	8·478	3·176	3·90	0·5
13th January 1910 .	14·44	55·79	8·478	3·176	3·90	0·5
14th January 1910 .	13·69	43·20	8·478	3·176	3·90	0·5
15th January 1910 .	17·44	61·95	8·478	3·176	3·90	0·5
16th January 1910 .	14·00	50·47	8·478	3·176	3·90	0·5

Average intake of nitrogen per man daily . . . 16·054 grms.

Average output of nitrogen in fæces per man daily . . 4·9094 grms

Nitrogen absorbed—11·1446 grms.=69·4 per cent. of nitrogen of diet.

Serial No. 18.

Ten prisoners under observation for five days.

Wheat	6 chittacks.
Bajra	7 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
12th January 1910	13·00	40·01	5·652	5·553	3·90	0·5
13th January 1910	13·69	54·00	5·652	5·558	3·90	0·5
14th January 1910	13·50	50·84	5·652	5·558	3·90	0·5
15th January 1910	15·69	61·12	5·652	5·558	3·90	0·5
16th January 1910	16·20	56·96	5·652	5·558	3·90	0·5

Average intake of nitrogen per man daily . . . 15·61 grms.

Average output of nitrogen in fæces per man daily . . 5·2586 grms.

Nitrogen absorbed—10·3514 grms. = 66·3 per cent. of nitrogen of diet.

Serial No. 19.

Ten prisoners under observation for six days.

Wheat	4 chittacks.
Bajra	8 „
Urid	2 „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Urid.	Nitrogen of Arhar.	Nitrogen of Vegetables.
14th December 1909	11·00	343·08 grms.	3·768	6·3526	4·00	1·95	0·5
15th December 1909	12·50		3·768	6·3526	4·00	1·95	0 5
16th December 1909	15·00		3·768	6·3526	4·00	1·95	0·5
17th December 1909	14·00		3·768	6·3526	4·00	1·95	0·5
18th December 1909	12·50		3·768	6·3526	4·00	1·95	0·5
19th December 1909	11·00		3·768	6·3526	4·00	1 95	0·5

Average intake of nitrogen per man daily . . . 16·5706 grms.

Average output of nitrogen in fæces per man daily . . 5·7180 grms.

Nitrogen absorbed—10·8526 grms. or 65·5 per cent. of nitrogen of diet.

Serial No. 20.

Four prisoners under observation for six days.

Wheat . . . . . 11½ chittacks.
Gram . . . . . 3½ „
Vegetables . . . . . 3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Vegetables.
2nd March 1910	89·00	16·33	10·1545	5·8758	0·5
3rd March 1910	85·00	17·67	10·1545	5·8758	0·5
4th March 1910	96·50	18·41	10·1545	5·8758	0·5
5th March 1910	113·50	22·53	10·1545	5·8758	0·5
6th March 1910	62·00	14·71	10·1545	5·8758	0·5
7th March 1910	95·50	21·14	10·1545	5·8758	0·5
8th March 1910	32·50	8·54	10·1545	5·8758	0·5

Average intake of nitrogen per man daily . . . 16·5303 grms.

Average output of nitrogen in fæces per man daily . . 4·9721 grms.

Nitrogen absorbed—11·5582 grms. = 69·9 per cent. of nitrogen of diet.

In the preceding pages we have recorded the investigations made with a view of obtaining some idea of the average amount of nitrogen absorbed from the several diets made use of in the jails of the United Provinces. The results point undoubtedly to Diet E of the Jail Code as being the best. It presents, on an average over the province, an intake of 17·09026 grms. of nitrogen of which 11·64996 grms., or 68·16 per cent., are absorbed. The other diets, whether given as sanctioned in the Jail Code or as made use of in the different jails, present a lower intake of nitrogen and are accompanied by a lesser degree of nitrogenous metabolism, both actually and relatively.

We may summarise the results so far obtained as follows :—

Diet E.—Intake of 17·09026 grms. Nitrogen absorbed 11·64996 grms. = 68·16 per cent.

Diet A.—Intake of 15·0020 grms. Nitrogen absorbed 9·7080 grms. = 64·7 per cent.

Diet G.—Intake of 14·3793 grms. Nitrogen absorbed 9·2264 grms. = 63·9 per cent.

Diet F.—Intake of 16·2748 grms. Nitrogen absorbed 8·9992 grms. = 55·3 per cent.

Diet B.—Intake of 15·9799 grms. Nitrogen absorbed 9·5291 grms. = 59·6 per cent.

Diet $\frac{E+F}{2}$.—Intake of 15·8912 grms. Nitrogen absorbed 10·0055 grms. =62·9 per cent.

Diet in serial No. 14—Intake of 15·0444 grms. Nitrogen absorbed 10·0500 grms.=66·8 per cent.

Diet in serial No. 15—Intake of 14·8512 grms. Nitrogen absorbed 10·1888 grms.=68·6 per cent.

Diet in serial No. 16—Intake of 14·8640 grms. Nitrogen absorbed 10·7200 grms.=72·1 per cent.

Diet in serial No. 17—Intake of 16·0540 grms. Nitrogen absorbed 11·1446 grms.=69·4 per cent.

Diet in serial No. 18—Intake of 15·6100 grms. Nitrogen absorbed 10·3514 grms.=66·3 per cent.

Diet in serial No. 19—Intake of 16·5706 grms. Nitrogen absorbed 10·8526 grms.=65·5 per cent.

Diet in serial No. 20—Intake of 16·5303 grms. Nitrogen absorbed 11·5582 grms.=69·9 per cent.

It is, therefore, evident that with the exception of the diet investigated in serial number 20, which contains too much pulse to be given for any great length of time, Diet E of the Jail Code is the most suitable of all those under observation. This explains the partiality for this diet met with in the different jails. Experience has shown that the prisoners do better on it than on any of the other official combinations; so that it is used practically to the exclusion of all others for at least nine months of the year.

If now we accept that E forms the diet of the prisoners for nine months in the year and that one or other of the remaining diets is given during three months in the cold weather, we can estimate the average level of nitrogenous metabolism attained daily throughout the year. Thus for nine months the average daily nitrogenous interchanges=11·64995 grms. and for three months the daily nitrogenous metabolism may be taken as the average value of the remaining diets.

The average daily absorption from these remaining diets works out to be 10·1945 grms. per man, therefore the average daily nitrogenous interchange per man is $\frac{11{\cdot}64995\times3+10{\cdot}1945}{4}$=11·2860 grms. This works out to be equal to 67·4 per cent. of the average daily intake of nitrogen throughout the year, *viz.*, 16·7292 grms.

Therefore, an average daily intake throughout the year of 16·7292 grms. of nitrogen is provided for in the jail dietaries of the United Provinces, and of this amount 11·2860 grms., or 67·4 per cent., is absorbed and undergoes metabolism in the system.

When we come to discuss this diet in the light of further experimental work, the question will have to be considered whether this level of nitrogenous

interchange is sufficient; if not, how it can be raised, and, more important still, how the percentage absorbed, 67·47, can be increased so that excessive waste may be avoided.

SUMMARY AND CONCLUSIONS.

1. The food-stuffs of Allahabad and Benares districts are purer and show a higher degree of nitrogenous absorption than those of Agra, Lucknow or Mainpuri districts.

2. Of all the official diet scales and of several other combinations investigated Diet E of the Jail Code proves itself superior, which explains the preference shown by all Jail Superintendents for this diet.

It presents on an average throughout the province 17·09 grms. of nitrogen, or 106·81 grms. of protein, per man daily, and permits of an absorption of 11·65 grms. nitrogen, or 72·81 grms. of protein.

3. Taking the whole year into consideration the dietaries of the jails of the United Provinces present an average daily intake of 16·73 grms. nitrogen, or 104·56 grms. protein per man, and are accompanied by an average daily absorption of 11·28 grms. nitrogen, or 69·50 grms. protein per man.

CHAPTER IV.

The Determination of the Co-efficients of Absorption of the Nitrogen offered in the Food-Stuffs entering into the Jail Dietaries of the United Provinces.

In our work on Bengal Jail Dietaries [1] it was found to be impossible to obtain any constant figures that would represent the percentages of the nitrogen absorbed from the different food-materials in use in Bengal Jails. The reason for this was ascribed to the very bulky condition of those diets when cooked. We ascertained that on a gradual increase of any one constituent, as for instance rice,—the other food-materials entering into the diet being kept constant in quantity—there is a gradual fall in the percentage of the nitrogen of the diet that is absorbed and this decrease becomes all the more marked the more the quantity of rice is increased. There is, therefore, a certain optimum quantity of rice, when the other constituents are constant, which permits of the greatest amount of nitrogen being absorbed from such a series of diets. It is evident, therefore, that with a change in quantity of a bulky constituent like rice, there will be changes in the percentage of nitrogen absorbed from the different food-stuffs constituting the diet. In other words, as the bulk of a diet beyond a certain stage increased the actual and relative amount of protein absorbed was found to decrease. In Bengal Jail diets we had therefore to deal with continually varying co-efficients of nitrogen absorption from the different food-materials, the variations depending on the extent to which the bulk of the diet interfered with the proper digestion and assimilation of its proximate principles.

This difficulty is not met with in diets of the type made use of in the jails of the United Provinces. The ordinary dietaries are nothing like so bulky as was the case in Bengal. The observations made show that it is quite possible and fairly simple to obtain figures which represent the nitrogen absorption from the different food-stuffs, and that those figures are, to all intents and purposes, constant so long as the same samples of food-materials are experimented with. Any change, however, in the sample is immediately accompanied by a change in the percentage of nitrogen absorbed. An illustration will make our meaning clear. Supposing a good sample of wheat shows 80 per cent. of its nitrogen absorbed, and a good sample of barley shows 55 per cent. of its nitrogen absorbed. Now a certain amount of admixture of these two cereals is practically always the case, and it will be evident that different degrees of admixture will show different percentages of protein absorption, although those different admix-

[1] Scientific Memoirs, No. 37.

tures are all classed as wheat. The fact that we obtained different results with seemingly the same diet in different jails gave us for a time a good deal of trouble and a certain amount of unnecessary repetition of experiments. The difficulty arises largely with wheat and barley, although the other food-stuffs are often mixed to a greater or lesser extent. Government, no doubt recognising the difficulty of obtaining pure food-materials, only demands second class quality for jail consumption; the result of this is that, wheat being by far the most expensive of the different food-materials, the contractors supply wheat, unless carefully watched, that contains a very large proportion of barley, juar or even gram. We have seen samples of wheat sent in for jail consumption which were fully 50 per cent. barley and, as if that were not sufficient; in which both wheat and barley were weevil eaten, the grain being considerably damaged. Needless to say the absorption of nitrogen from diets containing that type of wheat is far below what should be the case. It is evident, therefore, in order to get anything like constant results we had to arrange that the same quality of the different food-stuffs should be given during a series of observations. When this was done the results worked out remarkably close.

We shall now proceed to record the investigations carried out with a view of ascertaining the absorption co-efficients of the nitrogen offered in the food-stuffs entering into the jail dietaries of the United Provinces. Before doing so, however, for the sake of comparison we shall show what the absorption of nitrogen should be from wheat that may be looked on as of first class quality. This wheat was specially procured for the purposes of the experiment and was a good deal superior to the ordinary sample of wheat in use in the jail. It showed on analyses considerably more protein than was present in any other sample of wheat analysed from jails in the United Provinces, *viz.*, an average of 12 per cent. as compared with a little over 10 per cent. on an average of the wheat from different jails.

The Co-efficient of Absorption of the Nitrogen of first class Wheat.

BENARES JAIL.

SERIAL NO. 21. BATCH A.

Six prisoners under observation for five days.

First class Wheat	11½	chittacks.
Arhar	2	„
Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of egetables.
13th January 1910 . . .	4·15	19·01	12·314	3·90	0·5
14th January 1910 . . .	3·43	17·73	12·314	3·90	0·5
15th January 1910 . . .	5·18	23·50	12·314	3·90	0·5
16th January 1910 . . .	3·31	15·47	12·314	3·90	0·5
17th January 1910 . . .	4·00	16·98	12·314	3·90	0·5

Average intake of nitrogen per man daily . . . 16·714 grms.

Average output of nitrogen in fæces per man daily . . . 3·0896 grms.

Nitrogen absorbed—13·6244 grms. = 81·5 per cent. of nitrogen of diet.

Serial No. 22. Batch A.

The same six prisoners were kept on the same diet for seven days longer.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Vegetables.
19th January 1910 . . .	4·56	22·42	12·314	3·90	0·5
20th January 1910 . . .	2·47	13·87	12·314	3·90	0·5
22nd January 1910 . . .	3·03	15·05	12·314	3·90	0·5
23rd January 1910 . . .	4·25	20·76	12·31	3·90	0·5
24th January 1910 . . .	2·87	15·19	12·314	3·90	0·5
25th January 1910 . . .	5·68	25·51	12·314	3·90	0·5
26th January 1910 . . .	3·42	15·05	12·314	3·90	0 5

Average intake of nitrogen per man daily . . . 16·714 grms.

Average output of nitrogen in fæces per man daily . . . 3·04404 grms.

Nitrogen absorbed—13·6699 grms. = 81·7 per cent. of nitrogen of diet.

Therefore, over the twelve days these six prisoners show a daily nitrogen intake of 16·724 grms. of which 13·651 grms., or 81·6 per cent., are absorbed.

We shall presently see that the nitrogen of arhar plus vegetables shows an absorption of 84·1 per cent. Therefore, 12·314 grms. nitrogen of wheat shows 13·651—3·7004=9·9506 grms. nitrogen absorbed.

Therefore, 1st class wheat has 80·8 per cent. of its nitrogen absorbed.

Serial No. 23. Batch C.

Five prisoners under observation for seven days.

1st class	Wheat	5	chittacks.
	Juar	8	„
	Arhar	2	„
	Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
19th January 1910 .	3·11	17·61	5·354	5·11	3·90	0·5
20th January 1910 .	2·36	12·61	5·354	5·11	3·90	0·5
21st January 1910 .	3·92	21·55	5·354	5·11	3·90	0·5
22nd January 1910 .	3·42	19·45	5·354	5·11	3·90	0·5
23rd January 1910 .	5·64	29·83	5·354	5·11	3·90	0·5
24th January 1910 .	4·23	22·43	5·354	5·11	3·90	0·5
25th January 1910 .	3·60	21·56	5·354	5·11	3·90	0·5

Average intake of nitrogen per man daily . . . 14·864 grms.

Average output of nitrogen in fæces per man daily . . 4·144 grms.

Nitrogen absorbed—10·72 grms. = 72·1 per cent. of nitrogen of diet.

Serial No. 24. Batch B.

Five prisoners under observation for three days and four prisoners for the remaining four days.

1st class	Wheat	3	chittacks.
	Juar	8	„
	Arhar	2	„
	Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
19th January 1910 .	2·26	17·22	3·212	5·11	3·90	0·5
20th January 1910 .	3·32	20·82	3·212	5·11	3·90	0·5
21st January 1910 .	2·37	15·88	3·212	5·11	3·90	0·5
22nd January 1910	2·23	14·97	3·212	5·11	3·90	0·5
23rd January 1910 .	2·42	16·47	3·212	5·11	3·90	0·5
24th January 1910 .	3·31	20·32	3·212	5·11	3·90	0·5
25th January 1910 .	1·50	9·77	3·212	5·11	3·90	0·5

Average intake of nitrogen per man daily . . . 12·722 grms.

Average output of nitrogen in fæces per man daily . . 3·7242 grms.

Nitrogen absorbed—8·9978 grms. = 70·7 per cent. nitrogen of diet.

By taking observations 23 and 24 together we see that a difference of 2 chittacks of 1st class wheat, equal to 2·142 grms. nitrogen, causes a difference of 1·7222 grms. in the amount of nitrogen absorbed.

Therefore, this 1st class wheat shows 80·4 per cent. of its nitrogen absorbed.

Other determinations of the absorption of the nitrogen of 1st class wheat will be given amongst the results obtained from work done on prisoners in Benares Jail.

THE DETERMINATION OF THE CO-EFFICIENT OF NITROGEN ABSORPTION FROM THE FOOD-STUFFS ENTERING INTO THE JAIL DIETARIES OF THE UNITED PROVINCES.

A.—BENARES JAIL.

(1) The Absorption of the Nitrogen of ordinary Jail Wheat.

SERIAL NO. 25. BATCH A.

Five prisoners under observation for six days.

Wheat	11½ chittacks.
Gram	2½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th February 1910 .	4·39	17·98	11·174	4·111	1·95	0·5
19th February 1910 .	4·57	20·90	11·174	4·111	1·95	0·5
20th February 1910 .	4·56	20·62	11·174	4·111	1·95	0·5
21st February 1910 .	7·32	32·68	11·174	4·111	1·95	0·5
22nd February 1910 .	5·51	24·42	11·174	4·111	1·95	0·5
23rd February 1910 .	8·51	32·82	11·174	4·111	1·95	0·5
24th February 1910 .	3·86	16·72	11·174	4·111	1·95	0·5

Average intake of nitrogen per man daily . . . 17·735 grms.

Average output of nitrogen in fæces per man daily . . 5·538 grms.

Nitrogen absorbed—12·197 grms. = 68·7 per cent. of nitrogen of diet.

Reference to serial number 2 will show that on a similar diet with the same food-materials this same batch of prisoners absorbed 12·272 grms.

We may accept, therefore, the average, 12·2345 grms., as a true measure of the absorption.

Serial No. 26. Batch B.

Five prisoners under observation for six days.

Wheat	10	chittacks.
Gram	2	,,
Arhar	1	chittack.
Vegetables	3	chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th February 1910 .	4·34	15·34	9·716	4·111	1·95	0·5
19th February 1910 .	6·21	24·51	9·716	4·111	1·95	0·5
20th February 1910 .	6·25	24·61	9·716	4·111	1·95	0·5
21st February 1910 .	5·34	21·80	9·716	4·111	1·95	0·5
22nd February 1910 .	5·12	21·37	9·716	4·111	1·95	0·5
23rd February 1910 .	7·78	28·64	9·716	4·111	1·95	0·5
24th February 1910 .	3·09	15·33	9·716	4·111	1·95	0·5

Average intake of nitrogen per man daily . . . 16·277 grms.

Average output of nitrogen in fæces per man daily . . 5·0533 grms.

Nitrogen absorbed—11·2237 grms.=68·9 per cent. of nitrogen of diet.

Now by taking this result in conjunction with the average of the two observations given under No. 25 we see that a difference of $1\frac{1}{2}$ chittacks of wheat, or 1·458 grms. nitrogen, causes a difference of 12·2345—11·2237 equals 1·0108 grms. nitrogen in absorption.

Therefore, the ordinary sample of jail wheat shows 69·3 per cent. of its nitrogen absorbed.

(2) The Absorption of the Nitrogen of Gram

Serial No. 27. Batches B and C.

Ten prisoners under observation for six days.

1st class Wheat	10	chittacks.
Gram	$2\frac{1}{2}$	,,
Arhar	1	chittack.
Vegetables	3	chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
6th February 1910 .	6·27	29·42	10·708	4·111	1·95	0·5
7th February 1910 .	7·19	38·42	10·708	4·111	1·95	0·5
8th February 1910 .	7·67	36·85	10·708	4·111	1·95	0·5
9th February 1910 .	10·07	41·88	10·708	4·111	1·95	0·5
10th February 1910 .	9·76	40·86	10·708	4·111	1·95	0·5
11th February 1910 .	9·26	37·86	10·708	4·111	1·95	0·5
12th February 1910 .	2·57	13·87	10·708	4·111	1·95	0·5

Average intake of nitrogen per man daily . . . 17·269 grms. Average output of nitrogen in fæces per man daily . . 3·9910 grms.

Nitrogen absorbed—13·278 grms. = 77 per cent. of nitrogen of diet.

But we know from the observations recorded under Nos. 21 and 22 that 81·6 per cent. of the nitrogen of wheat, arhar and vegetables is absorbed. Substitute this for the nitrogen of wheat, arhar and vegetables and we get 13·158 × 81·6 equals 10·7369 grms. nitrogen. Therefore 4·111 grms. nitrogen of gram shows 13·278—10·7369 grms. absorption. Therefore, the nitrogen of gram shows 61·8 per cent. absorbed.

Serial No. 28. Batch A.

Five prisoners under observation for seven days.

1st class Wheat . . . . . 11½ chittacks.
Gram . . . . . 2½ „
Arhar . . . . . 1 chittack.
Vegetables . . . . . 3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
6th February 1910 .	4·51	22·18	12·314	4·111	1·95	0·5
7th February 1910 .	4·68	23·63	12·314	4·111	1·95	0·5
8th February 1910 .	6·76	29·55	12·314	4·111	1·95	0·5
9th February 1910 .	5·45	24·99	12·314	4·111	1·95	0·5
10th February 1910 .	6·57	20·71	12·314	4·111	1·95	0·5
11th February 1910 .	4·16	15·33	12·314	4·111	1·95	0·5
12th February 1910 .	4·51	15·81	12·314	4·111	1·95	0·5

Average intake of nitrogen per man daily . . . 18·875 grms. Average output of nitrogen in fæces per man daily . . 4·322 grms.

Nitrogen absorbed—14·553 grms. = 77·1 per cent. of nitrogen of diet.

Now as before substitute 81·6 per cent. of the nitrogen of the wheat, arhar and vegetables and we get the amount absorbed from these constituents, that is, 14·764 × 81·6 equals 12·0474 grms. nitrogen.

Therefore 4·111 grms. nitrogen of gram shows 14·553 – 12·0474 grms.

Therefore 4·111 grms. nitrogen shows 2·5056 grms. absorbed.

Therefore nitrogen of gram shows 60·9 per cent. absorbed.

By taking these last two observations, Nos. 27 and 28, together we see that a difference of 1½ chittacks of first class wheat, or 1·606 grms. nitrogen, causes a difference of 14·553—13·278 equals 1·275 grms. in the amount of nitrogen absorbed.

Therefore nitrogen of first class wheat shows 79·3 per cent. absorption.

Also from No. 27, 4·111 grms. nitrogen of gram shows 2·5411 grms. absorbed.

And from No. 28, 4·111 grms. nitrogen of gram shows 2·5056 grms. absorbed.

Therefore 8·222 grms. nitrogen of gram shows 5·0467 grms. absorbed.

Therefore the nitrogen of gram shows 61·38 per cent. absorbed.

(3) The Absorption of the Nitrogen of Arhar Dal and Vegetables.

Serial No. 29.

From Nos. 21 and 22 we learned that a diet composed of—

1st class	Wheat . .	11½	chittacks	offering	12·314	grms.	nitrogen.
	Arhar . . .	2	„	„	3·90	„	„
	Vegetables . .	3	„	„	0·50	„	„

showed 13·651 grms. of nitrogen absorbed.

By Nos. 23 and 24 we learned that 80·4 per cent. of nitrogen of 1st class wheat was absorbed.

By Nos. 27 and 28 we learned that 79·3 per cent. of nitrogen of 1st class wheat was absorbed.

i. e., from 23 and 24,	2·142	grms.	nitrogen	showed	an	absorption	of	1·7222	grms. and
from 27 and 28,	1·606	„	„	„	„	„	„	1·2750	„
therefore	3·748	„	„	„	„	„	„	2·9972	„

Therefore, the average absorption of the nitrogen of 1st class wheat is as nearly possible 80 per cent.

Substitute this value for the absorption of the nitrogen of wheat in No. 29 and we obtain the absorption from arhar and vegetables.

Thus, 12·314 × 80 equals 13·651—4·4 grms. (Arhar and vegetables). Therefore, 4·4 grms. (Arhar and vegetables) equals 13·651—9·8512 grms. nitrogen=3·7998 grms. nitrogen absorbed.

Therefore, the absorption of the nitrogen from arhar dal and vegetables works out at 84·1 per cent.

The Absorption of the Nitrogen of First Class Wheat.

Serial No. 30.

Nos. 27 and 28 added together give an absorption of 27·831 grms. nitrogen

from

Nitrogen of Wheat	23·022	grms.
„ „ Gram	8·222	„
„ „ Arhar	3·900	„
„ „ Vegetables	1·000	„

Now substitute our average values for the absorption of the nitrogen of gram, *viz.*, 61·38 per cent., and nitrogen of arhar and vegetables, *viz.*, 84·1 per cent.

Therefore, the 23·022 grms. nitrogen of wheat equals 27·831—(8·222 × 61·38+4·90 × 84·1)=27·831—9·1675 grms. absorbed.

Therefore, the nitrogen of 1st class wheat shows an absorption of 81·06 per cent.

The Absorption of the Nitrogen of the ordinary Jail Wheat.

Serial No. 31.

Nos. 25 and 26 added together give an absorption of 23·4207 grms. nitrogen

from

Nitrogen of Wheat	20·890	grms.
„ of Gram	8·222	„
„ of Arhar	3·900	„
„ of Vegetables	1·000	„

Substitute as in No. 30.

Therefore, 20·89 grms. nitrogen of wheat=23·4207—9·1675 grms. absorbed.

Therefore, the nitrogen of ordinary jail wheat shows an absorption of 68·3 per cent.

(4) The Absorption of the Nitrogen of Juar.

Serial No. 32.

From serial number 30 we learned that—

23·022 grms. nitrogen of wheat showed 18·6635 grms. absorbed.

From serial number 29 we learned that—

3·748 grms. nitrogen of wheat showed 2·9972 „ „

Therefore 26·770 „ „ „ „ 21·6607 „ „

Therefore, nitrogen of 1st class wheat shows 80·8 per cent. absorbed.

Serial No. 33. Batch C.

Five prisoners under observation for seven days.

1st class	Wheat	5	chittacks.
	Juar	8	„
	Arhar	2	„
	Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen o f fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Juar.	Nitrogen of Vegetables.
19th January 1910 .	3·11	17·61	5·354	3·90	5·11	0·5
20th January 1910 .	2·36	12·61	5·354	3·90	5·11	0·5
21st January 1910 .	3·92	21·55	5·354	3·90	5·11	0·5
22nd January 1910 .	3·42	19·45	5·354	3·90	5·11	0·5
23rd January 1910 .	5·64	29·83	5·354	3·90	5·11	0·5
24th January 1910 .	4·23	22·43	5·354	3·90	5·11	0·5
25th January 1910 .	3·60	21·56	5·354	3·90	5·11	0·5

Average intake of nitrogen per man daily . . . 14·864 grms.

Average output of nitrogen in fæces per man daily . . 4·144 grms.

Nitrogen absorbed—10·72 grms. =72·1 per cent. of nitrogen of diet.

By substituting the values found for the absorption of the nitrogen of first quality wheat and for arhar and vegetables we get the percentage of the nitrogen of juar that is absorbed. Thus :—

$5{\cdot}354 \times 80{\cdot}8 + 4{\cdot}4 \times 84{\cdot}1 + 5{\cdot}11$ juar $= 10{\cdot}72$ grms. nitrogen absorbed.

Therefore, the 5·11 grms. nitrogen of juar $= 10{\cdot}72 - 8{\cdot}0264$ grms.

Therefore, the nitrogen of juar shows 52·7 per cent. absorbed.

Serial No. 34. Batch B.

Five prisoners under observation for three days and four prisoners for the remaining four days.

1st class Wheat	3 chittacks.
Juar	8 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
19th January 1910	2·26	17·22	3·212	5·11	3·90	0·5
20th January 1910	3·32	20·82	3·212	5·11	3·90	0·5
21st January 1910	2·37	15·88	3·212	5·11	3·90	0·5
22nd January 1910	2·23	14·97	3·212	5·11	3·90	0·5
23rd January 1910	2·42	16·47	3·212	5·11	3·90	0·5
24th January 1910	3·31	20·32	3·212	5·11	3·90	0·5
25th January 1910	1·50	9·77	3·212	5·11	3·90	0·5

Average intake of nitrogen per man daily . . . 12·722 grms.

Average output of nitrogen in fæces per man daily . . 3·7242 grms.

Nitrogen absorbed—8·9978 grms.=70·7 per cent. of nitrogen of diet.

By substituting the same values as in the preceding observation, No. 33, we obtain the percentage of the nitrogen of juar that is absorbed. Thus :—

$3{\cdot}212 \times 80{\cdot}8 + 4{\cdot}4 \times 84{\cdot}1 + 5{\cdot}11$ grms. nitrogen of juar $= 8{\cdot}9978$ grms. nitrogen absorbed.

Therefore, 5·11 grms. nitrogen of juar $= 8{\cdot}9978 - 6{\cdot}29569 = 2{\cdot}70211$ grms.

Therefore, the nitrogen of juar shows 52·8 per cent. absorbed.

Serial No. 35. Batch B.

Five prisoners under observation for five days.

1st class Wheat . . . . . 8 chittacks.
Juar . . . . . 6 „
Arhar . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
13th January 1910 .	4·40	18·96	8·566	3·832	3·90	0·5
14th January 1910 .	2·56	16·81	8·566	3·832	3·90	0·5
15th January 1910 .	3·87	20·72	8·566	3·832	3·90	0·5
16th January 1910 .	4·58	23·85	8·566	3·832	3·90	0·5
17th January 1910 .	4·06	20·90	8·566	3·832	3·90	0·5

Average intake of nitrogen per man daily . . . 16·798 grms.

Average output of nitrogen in fæces per man daily . . 4·0496 grms.

Nitrogen absorbed—12·7484 grms.=75·9 per cent. of nitrogen of diet.

By substituting the same values as in the preceding observations, Nos. 33 and 34, we obtain the percentage of the nitrogen of juar absorbed. Thus :—

8·566×80·8+4·4×84·1+3·832 grms. nitrogen of juar=12·7484 grms. absorbed.

Therefore, 3·832 grms. nitrogen of juar=12·7484—10·6217 grms. absorbed.

Therefore, the nitrogen of juar shows 55·5 per cent. absorbed.

Serial No. 36. Batch C.

Six prisoners under observation for five days.

1st class Wheat . . . . . 8 chittacks.
Juar . . . . . 4 „
Arhar . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
13th January 1910 .	4·36	20·08	8·566	2·555	3·90	0·5
14th January 1910 .	4·90	23·00	8·566	2·555	3·90	0·5
15th January 1910 .	4·25	17·65	8·566	2·555	3·90	0·5
16th January 1910 .	4·48	20·00	8·566	2·555	3·90	0·5
17th January 1910 .	5·78	23·84	8·566	2·555	3·90	0·5

Average intake of nitrogen per man daily . . . 15·521 grms.

Average output of nitrogen in fæces per man daily . . 3·4856 grms.

Nitrogen absorbed—12·0354 grms.=77·6 per cent. of nitrogen of diet.

By substituting the same values as in the preceding observations, Nos. 33, 34 and 35, we obtain the percentage of the nitrogen of juar absorbed. Thus:—

$8{\cdot}566 \times 80{\cdot}8 + 4{\cdot}4 \times 84{\cdot}1 + 2{\cdot}555$ grms. nitrogen of juar = 12·0354 grms.

Therefore, 2·555 grms. nitrogen of juar=12·0354—10·6217 grms. absorbed.

Therefore, the nitrogen of juar shows 55·3 per cent. absorbed.

Serial No. 37.

By taking the two observations, Nos. 35 and 36, together we find that a difference of 2 chittacks of juar causes a difference of—

12·7484—12·0354=0·7130 grms. in the amount of nitrogen absorbed, *i.e.*,

1·277 grms. nitrogen of juar shows 0·713 grms. absorbed.

Therefore, the nitrogen of juar shows 55·8 per cent. absorbed.

Serial No. 38.

Collating these five observations for the determination of the co-efficient of the nitrogen absorption of juar we get:—

From No.	33	5·11	grms.	nitrogen	of	juar	shows	2·6936	grms.	absorbed.
„ „	34	5·11	„	„	„	„	„	2·7022	„	„
„ „	35	3·832	„	„	„	„	„	2·1267	„	„
„ „	36	2·555	„	„	„	„	„	1·4137	„	„
„ „	37	1·277	„	„	„	„	„	0·7130	„	„
Therefore		17·884	„	„	„	„	„	9·6492	„	„

Therefore, the nitrogen of juar shows 53·95 per cent. absorbed, or practically 54 per cent.

The Absorption of the Nitrogen of Arhar Dal and Vegetables.

Serial No. 39.

By making use of the four separate observations, Nos. 33, 34, 35 and 36, for the determination of the nitrogen absorption of juar we can, by introducing known factors, determine what the absorption of nitrogen is from the other constituents. Thus :—

	Wheat, nitrogen in grms.	Juar, nitrogen in grms.	Arhar and Vegetables, nitrogen in grms.	Nitrogen absorbed. grms.
No. 33 shows	5·354	5·11	4·4	10·72
„ 34 „	3·212	5·11	4·4	8·9978
„ 35 „	8·566	3·832	4·4	12·7484
„ 36 „	8·566	2·555	4·4	12·0354
Therefore	25·698	+16·607	+17·6	=44·5016

Now we know from other results that 80·8 per cent. of nitrogen of this wheat is absorbed, and we have just shown that on the average 53·95 per cent. of the nitrogen of juar is absorbed ; therefore, by introducing these known factors, we can obtain the absorption of the nitrogen of arhar and vegetables—

i.e., 25·698×80·8+16·607×53·95+17·6 grms. nitrogen of arhar and vegetables =44·5016

Therefore, 20·76398+8·95947+17·6 grms. nitrogen (arhar + vegetables) =44·5016.

Therefore, 17·6 grms. nitrogen (arhar + vegetables) =44·5016—29·72345 grms.

Therefore, the nitrogen of arhar + vegetables shows 84 per cent. absorbed, a result agreeing with that already obtained from other observations.

(5) The Absorption of the Nitrogen of Barley.

Serial No. 40. Batch A.

Five prisoners under observation for six days.

2nd class Wheat	8 chittacks.
Barley	6 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
28th January 1910 .	1·71	8·76	7·7728	4·47	3·90	0·5
29th January 1910 .	5·14	25·58	7·7728	4·47	3·90	0·5
30th January 1910 .	7·15	32·24	7·7728	4·47	3·90	0·5
31st January 1910 .	5·51	24·12	7·7728	4·47	3·90	0·5
1st February 1910 .	5·21	22·62	7·7728	4·47	3·90	0·5
2nd February 1910 .	6·79	26·98	7·7728	4·47	3·90	0·5
3rd February 1910 .	2·39	11·35	7·7728	4·47	3·90	0·5

Average intake of nitrogen per man daily . . . 16·6428 grms.

Average output of nitrogen in fæces per man daily . . 5·055 grms.

Nitrogen absorbed—11·5878 grms. = 69·6 per cent. of nitrogen of diet.

But we have seen that ordinary jail wheat shows 69 per cent. of its nitrogen absorbed, and arhar + vegetables show 84·0 per cent. absorbed.

Therefore, $7·7728 \times 69 + 4·47$ grms. nitrogen of barley $+ 4·4 \times 84 = 11·5878$.

Therefore, 4·47 grms. nitrogen of barley show 11·5878—9·0592 grms.

Therefore, the nitrogen of barley shows 56·5 per cent. absorption.

Serial No. 41. Batch D.

Five prisoners under observation for six days.

2nd class Wheat . . . . . 8 chittacks.
Barley . . . . . 4 „
Arhar . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
6th February 1910 .	3·04	11·86	7·7728	2·98	3·90	0·5
7th February 1910 .	6·70	25·87	7·7728	2·98	3·90	0·5
8th February 1910 .	4·00	16·98	7·7728	2·98	3·90	0·5
9th February 1910 .	6·95	25·58	7·7728	2·98	3·90	0·5
10th February 1910 .	3·89	17·70	7·7728	2·98	3·90	0·5
11th February 1910 .	7·62	24·84	7·7728	2·98	3·90	0·5
12th February 1910 .	2·01	9·08	7·7728	2·98	3·90	0·5

Average intake of nitrogen per man daily . . . 15·1528 grms.

Average output of nitrogen in fæces per man daily . . 4·397 grms.

Nitrogen absorbed—10·7558 grms. = 70·9 per cent. of nitrogen of diet.

Now introduce the same factors as in No. 40 for the absorption of the nitrogen of wheat and arhar dal plus vegetables, and we get $7{\cdot}7728 \times 69 + 2{\cdot}98$ grms. nitrogen barley $+4{\cdot}4 \times 84 = 10{\cdot}7558$ grms.

Therefore, 2·98 grms. nitrogen of barley $= 10{\cdot}7558 - 9{\cdot}0592$ grms. nitrogen absorbed.

Therefore, the nitrogen of barley shows 56·9 per cent. absorbed.

Serial No. 42.

By taking these two observations, Nos. 40 and 41, together we find that an increase of 2 chittacks of barley causes an increase in the amount of nitrogen absorbed of—

$$11{\cdot}5878 - 10{\cdot}7558 = 0{\cdot}8320 \text{ grms.}$$

i.e., a difference of 1·49 grms. nitrogen of barley causes a difference of—

0·832 grms. in absorption.

Therefore, the nitrogen of barley shows 55·8 per cent. absorbed.

Serial No. 43.

We may collate these three results for the determination of the absorption of the nitrogen of barley. Thus:—

No. 40	.	4·47	grms.	nitrogen	of	barley	showed	2·5286	grms.	absorbed.
„ 41	.	2·98	„	„	„	„	„	1·6966	„	„
„ 42	.	1·49	„	„	„	„	„	0·8320	„	„
Therefore		8·94	„	„	„	„	„	5·0572	„	„

Therefore, the nitrogen of barley shows 56·5 per cent. absorbed.

(6) The Absorption of the Nitrogen of Bajra.

Serial No. 44. Batch B.

Five prisoners under observation for six days.

1st class	Wheat	8	chittacks.
	Bajra	6	„
	Arhar	2	„
	Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
28th January 1910 .	1·18	6·13	8·566	4·764	3·90	0·5
29th January 1910 .	4·90	26·28	8·566	4·764	3·90	0·5
30th January 1910 .	4·54	23·82	8·566	4·764	3·90	0·5
31st January 1910 .	4·51	25·80	8·566	4·764	3·90	0·5
1st February 1910 .	4·21	21·66	8·566	4·764	3·90	0·5
2nd February 1910 .	4·93	23·30	8·566	4·764	3·90	0·5
3rd February 1910 .	2·62	15·98	8·566	4·764	3·90	0·5

Average intake of nitrogen per man daily . . . 17·730 grms.

Average output of nitrogen in fæces per man daily . . 4·7656 grms.

Nitrogen absorbed—12·9644 grms.=73·1 per cent. of nitrogen of diet.

As we know the co-efficient of nitrogen absorption of wheat and arhar dal plus vegetables, by substitution we can find that of bajra. Thus :—

8·566 × 80·8 + 4·764 grms. nitrogen of bajra + 4·4 × 84 = 12·9644 grms.

Therefore, 4·764 grms. nitrogen of bajra = 12·9644 − 10·16173 grms.

Therefore, the nitrogen of bajra shows 49·2 per cent. absorbed.

Serial No. 45. Batch C.

Five prisoners under observation for six days.

1st class Wheat	. . . . .	8 chittacks.
Bajra	. . . . .	4 „
Arhar	. . . . .	2 „
Vegetables	. . . . .	3 „

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
28th January 1910 .	3·00	14·68	8·566	3·176	3·90	0·5
29th January 1910 .	5·18	22·21	8·566	3·176	3·90	0·5
30th January 1910 .	3·00	14·68	8·566	3·176	3·90	0·5
31st January 1910 .	4·20	18·53	8·566	3·176	3·90	0·5
1st February 1910 .	4·45	19·83	8·566	3·176	3·90	0·5
2nd February 1910 .	5·60	21·44	8·566	3·176	3·90	0·5
3rd February 1910 .	1·42	7·70	8·566	3·176	3·90	0·5

Average intake of nitrogen per man daily . . 16·142 grms.

Average output of nitrogen in fæces per man daily . . 3·969 grms.

Nitrogen absorbed—12·173 grms.=75·4 per cent. of nitrogen of diet.

By substituting as in No. 44 we can obtain the nitrogen absorption of bajra, *i.e.*, 8·566×80·8+3·176 grms. nitrogen of bajra+4·4×84=12·173 grms.

Therefore, 3·176 grms. nitrogen of bajra=12·173—10·6173 grms.

Therefore, the nitrogen of bajra shows 48·99 per cent. absorbed, practically 49 per cent.

SERIAL No. 46.

By taking these last two observations, Nos. 44 and 45, together we see that a difference of 2 chittacks of bajra causes a difference of 12·9644 — 12·173 grms. =0·7914 grms. in the amount of nitrogen absorbed.

i.e., 1·588 grms. nitrogen of bajra shows 0·7914 grms. absorbed.

Therefore, the nitrogen of bajra shows 49·8 per cent. absorbed.

SERIAL No. 47.

We may collate these three results for the determination of the absorption of the nitrogen of bajra. Thus :—

No. 44	. 4·764 grms.	nitrogen of bajra showed	2·3471 grms. absorbed.
„ 45	. 3·176 „	„ „ „ „ „	1·5557 „ „
„ 46	. 1·588 „	„ „ „ „ „	0·7914 „ „
Therefore	. 9·528 „	„ „ „ „ „	4·6942 „ „

Therefore, the nitrogen of bajra shows 49·2 per cent. absorbed.

SUMMARY OF RESULTS OBTAINED IN BENARES JAIL.

(1) The Co-efficient of the Absorption of the Nitrogen of First Class Wheat.

From Nos. 21 and 22 the absorption works out to be 80·8 per cent.
„ „ 23 „ 24 „ „ „ „ „ „ 80·4 „ „
„ No. 28 „ „ „ „ „ „ 79·3 „ „
„ „ 30 „ „ „ „ „ „ 81·06 „ „
„ „ 31 „ „ „ „ „ „ 80·8 „ „

Therefore, the average absorption of nitrogen of first class wheat is practically 80·5 per cent.

(2) The Co-efficient of the Absorption of the Nitrogen of ordinary Jail Wheat.

From Nos. 25 and 26 the absorption works out to be 69·3 per cent.
„ No. 31 „ „ „ „ „ „ 68·3 „ „

Therefore, the average absorption of the nitrogen of ordinary jail wheat is 68·8 per cent.

(3) The Co-efficient of the Absorption of the Nitrogen of Gram Dal.

From No. 27 the absorption works out to be 61·8 per cent.
„ „ 28 „ „ „ „ „ „ 60·9 „ „

Therefore, the average absorption of the nitrogen of gram dal is 61·3 per cent.

(4) The Co-efficient of the Absorption of the Nitrogen of Arhar Dal and Vegetables.

From No. 29 the absorption works out to be 84·1 per cent.
„ „ 39 „ „ „ „ „ „ 84·0 „ „

Therefore, the average absorption of the nitrogen of arhar dal and vegetables is 84 per cent.

(5) The Co-efficient of the Absorption of the Nitrogen of Juar.

From No. 33 the absorption works out to be 52·7 per cent.
„ „ 34 „ „ „ „ „ „ 52·8 „ „
„ „ 35 „ „ „ „ „ „ 55·5 „ „
„ „ 36 „ „ „ „ „ „ 55·3 „ „
„ „ 37 „ „ „ „ „ „ 55·8 „ „
„ „ 38 „ „ „ „ „ „ 54·0 „ „

Therefore, the average absorption of the nitrogen of juar is 54·4 per cent.

(6) The Co-efficient of the Absorption of the Nitrogen of Barley.

From No. 40 the absorption works out to be 56·5 per cent.
„ „ 41 „ „ „ „ „ „ 56·9 „ „
„ „ 42 „ „ „ „ „ „ 55·8 „ „
„ „ 43 „ „ „ „ „ „ 56·5 „ „

Therefore, the average absorption of the nitrogen of barley is 56·4 per cent.

(7) The Co-efficient of the Absorption of the Nitrogen of Bajra.

From No. 44 the absorption works out to be 49·2 per cent.
„ „ 45 „ „ „ „ „ „ 49·0 „ „
„ „ 46 „ „ „ „ „ „ 49·8 „ „
„ „ 47 „ „ „ „ „ „ 49·2 „ „

Therefore, the average absorption of the nitrogen of bajra is 49·3 per cent.

Therefore, for all practical purposes the percentages of the absorption of the nitrogen of the food-stuffs investigated in Benares Jail are :—

1. First quality of wheat . . . . . 80·5 per cent.
2. Second „ „ „ . . . . . 68·8 „ „
3. Gram dal . . . . . 61·3 „ „
4. Arhar dal plus vegetables . . . . 84·0 „ „
5. Juar . . . . . 54·4 „ „
6. Barley . . . . . 56·4 „ „
7. Bajra . . . . . 49·3 „ „

B.—NAINI JAIL, ALLAHABAD.

The observations carried out in Naini Jail, Allahabad, were with the ordinary food-stuffs in use in the jail. Naini Jail is situated fairly close to Benares and, as would be expected, the ordinary food-materials available for jail consumption were much of the same quality. The following results were obtained :—

(1) The Absorption of the Nitrogen of Bajra.

SERIAL NO. 48. BATCH B.

Five prisoners under observation for five days.

Wheat . . . . . 8 chittacks.
Bajra . . . . . 6 „
Arhar . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
16th February 1910 .	35·36	5·81	7·537	4·764	3·90	0·5
17th February 1910 .	129·15	35·73	7·537	4·764	3·90	0·5
18th February 1910 .	99·42	25·31	7·537	4·764	3·90	0·5
19th February 1910 .	117·36	27·40	7·537	4·764	3·90	0·5
20th February 1910 .	127·10	27·40	7·537	4·764	3·90	0·5
21st February 1910 .	109·67	26·47	7·537	4·764	3·90	0·5

Average intake of nitrogen per man daily . . . 16·7010 grms.

Average output of nitrogen in fæces per man daily . . 5·9248 grms.

Nitrogen absorbed—10·7762 grms. = 64·5 per cent. of nitrogen of diet.

Serial No. 49. Batch C.

Five prisoners under observation for two days and four prisoners for the remaining three days.

Wheat	8 chittacks.
Bajra	4 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
16th February 1910 .	36·90	8·84	7·537	3·176	3·90	0·5
17th February 1910 .	126·07	29·83	7·537	3·176	3·90	0·5
18th February 1910 .	110·70	25·89	7·537	3·176	3·90	0·5
19th February 1910 .	61·50	15·95	7·537	3·176	3·90	0·5
20th February 1910 .	92·25	22·23	7·537	3·176	3·90	0·5
21st February 1910 .	31·77	9·93	7·537	3·176	3·90	0·5

Average intake of nitrogen per man daily . . . 15·1130 grms.

Average output of nitrogen in fæces per man daily . 5·12136 grms.

Nitrogen absorbed—9·99164 grms.=66·1 per cent. of nitrogen of diet.

Serial No. 50.

By taking these two observations together we find that a difference of 2 chittacks of bajra causes a difference of 10·7762 — 9·99164 grms. nitrogen= 0·78456 grms. nitrogen absorbed, *i.e.*, 1·588 grms. nitrogen of bajra shows 0·78456 grms. absorbed. Therefore, the nitrogen of bajra shows 49·4 per cent. absorbed.

(2) The Absorption of the Nitrogen of Wheat.

Serial No. 51. Batch C.

Five prisoners under observation for five days.

Wheat	7 chittacks.
Bajra	7 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
23rd February 1910 .	95·00	16·86	6·594	5·558	3·90	0·5
24th February 1910 .	140·00	34·17	6·594	5·558	3·90	0·5
25th February 1910 .	157·25	37·30	6·594	5·558	3·90	0·5
26th February 1910 .	88·30	22·55	6·594	5·558	3·90	0·5
27th February 1910 .	141·40	34·48	6·594	5·558	3·90	0·5
28th February 1910 .	10·10	4·16	6·594	5·558	3·90	0·5

Average intake of nitrogen per man daily . . . 16·552 grms.

Average output of nitrogen in fæces per man daily . . 5·9810 grms.

Nitrogen absorbed—10·5710 grms. = 63·8 per cent. of nitrogen of diet.

Serial No. 52. Batch B.

Five prisoners under observation for five days.

Wheat . . . . . 5 chittacks.
Bajra . . . . . 7 „
Arhar . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Bajra.	Nitrogen of Arhar.	Nitrogen of Vegetables.
23rd February 1910 .	74·00	18·48	4·710	5·558	3·90	0·5
24th February 1910 .	96·25	24·45	4·710	5·558	3·90	0·5
25th February 1910 .	72·38	20·15	4·710	5·558	3·90	0·5
26th February 1910 .	81·64	24·55	4·710	5·558	3·90	0·5
27th February 1910 .	102·50	30·98	4·710	5·558	3·90	0·5
28th February 1910 .	40·40	13·37	4·710	5·558	3·90	0 5

Average intake of nitrogen per man daily . . . 14·668 grms.

Average output of nitrogen in fæces per man daily . . 5·2796 grms.

Nitrogen absorbed—9·3884 grms. = 64 per cent. of nitrogen of diet.

Serial No. 53.

By taking these two observations, Nos. 51 and 52, together we find a difference of 2 chittacks of wheat causes a difference of 10·5710—9·3884 grms. =1·1826 grms., *i.e.*, 1·884 grms. nitrogen shows 1·1826 grms. absorbed. Therefore, the nitrogen of wheat shows 62·8 per cent. absorbed.

SERIAL No. 54.

By assuming for the present that 83·8 per cent. of the nitrogen of arhar dal and vegetables will be absorbed, we can make use of these observations on the determination of the absorption of the nitrogen of wheat, Nos. 50 and 51, to corroborate the result. Thus:—

(*a*) From No. 51 we learned that—

6·594 grms. nitrogen of wheat . . .
5·558 „ „ „ bajra . . .
4·40 „ „ „ arhar + vegetables .
} give 10·5710 grms. nitrogen absorbed.

Now introduce 49·4 per cent. for the absorption of nitrogen of bajra
and 83·8 „ „ „ „ „ „ „ „ arhar + vegetables

and we get 6·594 grms. $+5·558 \times 49·4 + 4·4 \times 83·8 = 10·5710$ grms.
$= 10·5710 - 6·4328$ grms.

Therefore, the nitrogen of wheat shows 62·7 per cent. absorbed.

(*b*) Similarly from No. 52 we learned that—

4·710 grms. nitrogen of wheat . . .
5·558 „ „ „ bajra . . .
4·40 „ „ „ arhar + vegetables .
} give 9·3384 grms. absorbed.

By introducing the same factors as in the last, we get—

4·71 grms. nitrogen of wheat showing 9·3884—6·4328 grms. absorbed.
Therefore, the nitrogen of wheat shows 62·8 per cent. absorbed.

(3) The Absorption of the Nitrogen of Arhar Dal *plus* Vegetables.

SERIAL No. 55.

We now know that 49·4 per cent. of the nitrogen of bajra is absorbed, and that 62·8 per cent. of the nitrogen of wheat is absorbed. If we introduce these factors in the results given in Nos. 48 and 49 we can determine the absorption of the nitrogen of arhar dal plus vegetables.

(*a*) Thus :—From No. 43 we learned that—

7·537 grms. nitrogen of wheat . . .
4·764 „ „ „ bajra . . .
4·40 „ „ „ arhar + vegetables .
} give 10·7762 grms. absorbed.

i.e., $7·537 \times 62·8 + 4·764 \times 49·4 \times 4·4$ grms. nitrogen (arhar + vegetables) $= 10·7762$ grms. Therefore, 4·4 nitrogen (arhar + vegetables) $= 10·7762 - 7·0866$

=3·6896 grms. Therefore, the nitrogen of arhar plus vegetables shows 83·8 per cent. absorbed.

(*b*) Similarly, in No. 49 we learned that—

7·537 grms.	nitrogen of	wheat . . .	} give 9·99164 grms. absorbed.
3·176 „	„	„ bajra . . .	
4·40 „	„	„ arhar+vegetables .	

i.e., 7·537×62·8+3·176×49·4+4·4 (arhar + vegetables) =9·99164 grms.

Therefore, 4·4 grms. nitrogen (arhar+vegetables) =9·9964−6·30217 grms. =3·68947 grms.

Therefore, the nitrogen of arhar dal plus vegetables shows 83·8 per cent. absorbed.

(4) The Absorption of the Nitrogen of Urid Dal.

Serial No. 56.

Ten prisoners under observation for ten days.

Bajra	12 chittacks.
Urid	2 „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Bajra.	Nitrogen of Urid.	Nitrogen of Arhar.	Nitrogen of Vegetables.
2nd December 1909 .	11·50	645·08 grms.	9·5289	4·00	1·951	0·5
3rd December 1909 .	15·00		9·5289	4·00	1·951	0·5
4th December 1909 .	17·50		9·5289	4·00	1·951	0·5
5th December 1909 .	15·00		9·5289	4·00	1·951	0·5
6th December 1909 .	14·50		9·5289	4·00	1 951	0·5
7th December 1909 .	13·50		9·5289	4·00	1·951	0·5
8th December 1909 .	13·00		9·5289	4·00	1·951	0·5
9th December 1909 .	14·00		9·5289	4·00	1·951	0·5
10th December 1909 .	10·50		9·5289	4·00	1·951	0·5
11th December 1909 .	12·00		9·5289	4·00	1·951	0·5

Average intake of nitrogen per man daily . . . 15·9799 grms.

Average output of nitrogen in fæces per man daily . . 6·4508 grms.

Nitrogen absorbed—9·5291 grms. =59·6 per cent. of nitrogen of diet.

By substitution of the values found for the absorption of the nitrogen of bajra and arhar dal plus vegetables we can obtain the absorption of the nitrogen of urid dal. Thus :—

9·5289 × 49·4 + 4·0 grms. nitrogen of urid + 2·451 × 83·8 = 9·5291 grms.

Therefore, 4·0 grms. nitrogen urid shows 9·5291—6·7612 = 2·7679 grms. absorbed.

Therefore, the nitrogen of urifl dal shows 69·2 per cent. absorbed.

(5) The Absorption of the Nitrogen of the ordinary Jail Wheat in use in the cold weather.

Serial No. 57.

Ten prisoners under observation for ten days.

Wheat	11½	chittacks.
Gram	2½	„
Arhar	1	chittack.
Vegetables	3	chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
2nd December 1909	17·50	505·40 grms.	10·833	3·7705	1·90	0·5
3rd December 1909	15·50		10·833	3·7705	1·90	0·5
4th December 1909	21·00		10·833	3·7705	1·90	0·5
5th December 1909	19·50		10·833	3·7705	1·90	0·5
6th December 1909	16·50		10·833	3·7705	1·90	0·5
7th December 1909	16·00		10·833	3·7705	1·90	0·5
8th December 1909	18·00		10·833	3·7705	1·90	0·5
9th December 1909	16·50		10·833	3·7705	1·90	0·5
10th December 1909	16·50		10·833	3·7705	1·90	0·5
11th December 1909	12·50		10·833	3·7705	1·90	0·5

Average intake of nitrogen per man daily . . . 17·0035 grms.

Average output of nitrogen in fæces per man daily . . 5·054 grms

Nitrogen absorbed—11·9495 grms. = 70·2 per cent. of nitrogen of diet.

Serial No. 58.

Ten prisoners under observation for six days.

Wheat	10	chittacks.
Gram	2½	„
Arhar	1	chittack.
Vegetables	3	chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
14th December 1909 .	14·00	282·51 grms.	9·42	3·7705	1·95	0·5
15th December 1909. .	13·50		9·42	3·7705	1·95	0·5
16th December 1909 .	14·00		9·42	3·7705	1·95	0·5
17th December 1909 .	14·00		9·42	3·7705	1·95	0·5
18th December 1909 .	12·00		9·42	3·7705	1·95	0·5
19th December 1909 .	11·50		9·42	3·7705	1·95	0·5

Average intake of nitrogen per man daily . . . 15·6705 grms.

Average output of nitrogen in fæces per man daily . . 4·7085 grms.

Nitrogen absorbed—10·9620 grms. =70 per cent. of nitrogen of diet.

Serial No. 59.

By taking these two observations together we find that a difference of 1½ chittacks of wheat caused a difference of 11·9495 — 10·9620 grms. = 0·9875 grms.

Therefore, 1·413 grms. nitrogen of wheat shows an absorption of 0·9875 grms.

Therefore, the nitrogen of wheat shows 69·7 per cent. absorbed.

Serial No. 60.

Ten prisoners under observation for seven days.

Wheat	12	chittacks.
Arhar	2	„
Vegetables	3	„

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen o Vegetables.
22nd December 1909 . . .	12·00	295·25 grms.	11·304	3·90	0·5
23rd December 1909 . . .	11·00		11·304	3·90	0·5
24th December 1909 . . .	11·50		11·304	3·90	0·5
25th December 1909 . . .	10·00		11·304	3·90	0·5
26th December 1909 . . .	15·00		11·304	3·90	0 5
27th December 1909 . . .	15·00		11·304	3·90	0·5
28th December 1909 . . .	10·50		11·304	3·90	0·5

Average intake of nitrogen per man daily . . . 15·704 grms.

Average output of nitrogen in fæces per man daily . . 4·2171 grms.

Nitrogen absorbed—11·4869 grms. =73·1 per cent. of nitrogen of diet.

Serial No. 61.

By substituting the value for the absorption of the nitrogen of arhar dal plus vegetables, 83·8 per cent., in No. 60 we get the percentage of the nitrogen of wheat absorbed.

i.e., 11·304 grms. nitrogen of wheat + 4·4 × 83·8=11·4869 grms.

Therefore, 11·304 grms. nitrogen of wheat = 11·4869 — 3·6872 grms. = 7·7997 grms.

Therefore, the nitrogen of wheat shows 67·9 per cent. absorbed.

(6) The Absorption of the Nitrogen of Gram.

Serial No. 62.

(*a*) We learned from No. 57, that—

Wheat	11½ chittacks.	showed an absorption of 11·9495 grms.
Gram	2½ „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

Now introduce the known values for the absorption of the nitrogen of wheat and arhar dal plus vegetables and we obtain the percentage of the nitrogen of gram absorbed. Thus:—

10·833×68·8 + 3·7705 grms. nitrogen of gram + 2·40 × 83·8 =11·9495 grms.

Therefore, 3·7705 grms. nitrogen of gram = 11·9495 — 9·4643 grms. absorbed.

Therefore, the nitrogen of gram shows 65·9 per cent. absorbed.

(*b*) We learned from No. 58, that—

Wheat	10 chittacks.	showed an absorption of 10·9620 grms.
Gram	2½ „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

By introducing the same factors as in (*a*) we find 9·42 × 68·8 + 3·7705 grms. nitrogen of gram + 2·45 × 83·8 = 10·9620 grms.

i.e., 3·7705 grms. nitrogen of gram = 10·9620—8·4921 grms. absorbed.

Therefore, the nitrogen of gram shows 65·5 per cent. absorbed.

SUMMARY OF RESULTS OBTAINED IN NAINI JAIL.

(1) The Co-efficient of the Absorption of the Nitrogen of Bajra.

From Nos. 48, 49 and 50, the absorption works out to be 49·4 per cent.

(2) The Co-efficient of the Absorption of the Nitrogen of Wheat.

From Nos. 51, 52 and 53, the absorption works out to be 62·8 per cent.
„ No. 54 (*a*), „ „ „ „ „ 62·7 „ „
„ „ 54 (*b*), „ „ „ „ „ 62·8 „ „

(3) The Co-efficient of the Absorption of the Nitrogen of Arhar Dal *plus* Vegetables.

From 55 (*a*), the absorption works out to be 83·8 per cent.
„ 55 (*b*), „ „ „ „ „ 83·8 „ „

(4) The Co-efficient of the Absorption of the Nitrogen of Urid Dal.

From No. 56, the absorption works out to be 69·2 per cent.

(5) The Co-efficient of the Absorption of the Nitrogen of a better sample of ordinary Jail Wheat.

From Nos. 57, 58 and 59, the absorption works out to be 69·7 per cent.
„ „ 60, and 61, „ „ „ „ „ 67·9 „ „

Therefore, the absorption is 68·8 per cent.

(6) The Co-efficient of the Absorption of the Nitrogen of Gram.

From No. 62 (*a*), the absorption works out to be 65·9 per cent.

„ „ 62 (*b*), „ „ „ „ „ 65·5 „ „

Therefore, the absorption is 65·7 per cent.

For all practical purposes we may accept the following values as representing the percentages of absorption of the nitrogen of the different food-stuffs in use in Naini Jail :—

1. First sample of ordinary jail wheat . . . . 62·8 per cent.
2. Second „ „ „ „ „ . . . . 68·8 „ „
3. Gram dal . . . . . 65·7 „ „
4. Arhar dal plus vegetables . . . . . 83·8 „ „
5. Urid dal . . . . . 69·2 „ „
6. Bajra . . . . . 49·4 „ „

When these results are contrasted with those obtained in Benares Jail it will be seen that, except with regard to the first sample of wheat, no very marked difference is met with.

This sample gave very inferior results when contrasted with the absorption of the nitrogen from wheat of first quality in Benares Jail, or even with the ordinary jail wheat of Benares, Lucknow, or the second sample in Naini Jail. When we come to deal with the food-stuffs of Agra Jail it will be found that the nitrogen absorption from the wheat in use in that jail is very inferior also.

The only explanation possible would appear to be the presence of much foreign material in the wheat. The second sample gave exactly the same percentage of nitrogen absorption as the ordinary jail wheat in Benares Jail, which may therefore be taken as a fair average for the absorption of nitrogen from the wheat commonly in use in the Allahabad and Benares districts.

Gram dal shows a higher percentage of absorption in Naini Jail than was obtained in Benares, otherwise the absorption of nitrogen from the several food-materials common to the two jails is very similar. We present the results in the following table :—

Food-material.	Benares Jail.	Naini Jail.
First quality wheat	80·5 per cent.	...
Ordinary Jail „	68·8 „ „	68·8 per cent.
„ „ „	...	62·8 „ „
Gram dal . . .	61·3 per cent.	66·9 „ „
Arhar dal *plus* vegetables . . .	84·0 „ „	83·8 „ „
Juar	54·4 „ „	...
Arhar dal	...	...
Barley	56·4 per cent.	...
Bajra	49·3 „ „	49·4 per cent.
Urid dal	...	69·2 „ „

C.—LUCKNOW JAIL.

The important points of distinction between the food-stuffs in use in Lucknow Jail and those in Benares Jail are the lower protein content of the wheat and the higher protein content of the barley. The average percentage of protein in the first quality of wheat in Benares Jail was almost 12 per cent., of ordinary jail wheat under 11 per cent., while in Lucknow Jail the wheat in daily use showed barely 10 per cent. protein. Barley, on the other hand, in Benares Jail showed just over 8 per cent., while in Lucknow Jail the protein content of barley was very high, up to 9·5 per cent. No great difference in chemical composition is evident from the analyses of the other food-materials investigated. Let us see what effect these variations have on the co-efficients of nitrogen absorption from the different food-stuffs.

(1) The Absorption of the Nitrogen of Wheat.

SERIAL NO. 63.

Five prisoners under observation for five days.

Wheat	11½ chittacks.
Arhar	2 ,,
Vegetables	3 ,,

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Vegetables.
10th March 1910 . . .	72·00	14·21	10·1545	4·0384	0·5
11th March 1910 . . .	71·00	14·92	10·1545	4·0384	0·5
12th March 1910 . . .	92·50	19·25	10·1545	4·0384	0·5
13th March 1910 . . .	76·50	15·89	10·1545	4·0384	0·5
14th March 1910 . . .	95·00	18·87	10·1545	4·0384	0 5
15th March 1910 . . .	31·00	11·42	10·1545	4·0384	0·5

Average intake of nitrogen per man daily . . . 14·6929 grms.

Average output of nitrogen in fæces per man daily . . 3·7828 grms.

Nitrogen absorbed—10·9101 grms.=74·2 per cent. of nitrogen of diet.

SERIAL NO. 64.

Five prisoners under observation for five days.

Wheat	14 chittacks.
Arhar	2 ,,
Vegetables	3 ,,

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Vegetables.
10th March 1910 . . .	77·50	16·70	12·362	4·0384	0·5
11th March 1910 . . .	100·00	22·22	12·362	4·0384	0·5
12th March 1910 . . .	99·50	21·72	12·362	4·0384	0·5
13th March 1910 . . .	88·50	20·15	12·362	4·0384	0·5
14th March 1910 . . .	78·00	18·86	12·362	4·0384	0·5
15th March 1910 . . .	31·50	10·71	12·362	4·0384	0·5

Average intake of nitrogen per man daily . . . 16·9004 grms.

Average output of nitrogen in fæces per man daily . . 4·414 grms.

Nitrogen absorbed—12·4864 grms. = 73·8 per cent. of the nitrogen of diet.

Serial No. 65.

By taking these two observations together, Nos. 63 and 64, it will be found that an increase of $2\frac{1}{2}$ chittacks of wheat, or 2·2075 grms. of nitrogen causes an increase of 12·4864 — 10·9101 grms., *i. e.*, 2·2075 grms. nitrogen of wheat shows 1·5763 grms. absorbed.

Therefore, the nitrogen of wheat shows 71·4 per cent. absorbed.

(2) The Absorption of the Nitrogen of Arhar Dal.

Serial No. 66.

From No. 63 we learned that a diet composed of—

Wheat	$11\frac{1}{2}$ chittacks	showed 10·9101 grms. nitrogen absorbed.
Arhar	2 „	
Vegetables . . .	3 „	

We further find that a diet composed of—

Wheat	$11\frac{1}{2}$ chittacks	*Four prisoners under observation for five days*
Arhar	3 „	
Vegetables . . .	3 „	

shows 12·5491 grms. absorbed. Thus :—

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Vegetables.
17th March 1910	45·50	8·77	10·1545	6·0576	0·5
18th March 1910	60·50	14·36	10·1545	6·0576	0·5
19th March 1910	75·00	18·50	10·1545	6·0576	0·5
20th March 1910	58·00	12·83	10·1545	6·0576	0·5
21st March 1910	80·20	20·83	10·1545	6·0576	0·5
22nd March 1910 . . .	24·35	7·97	10·1545	6·0576	0·5

Average intake of nitrogen per man daily . . . 16·7121 grms.

Average output of nitrogen in fæces per man daily . . . 4·163 grms.

Nitrogen absorbed—12·5491 grms. = 75·1 per cent. of nitrogen of diet.

Therefore, a difference of 1 chittack of arhar dal, or 2·0192 grms. nitrogen, causes a difference of 12·5491—10·9101 grms. nitrogen absorbed.

i.e., 2·0192 grms. nitrogen of arhar dal shows 1·6390 grms. absorbed.

Therefore, the nitrogen of arhar dal shows 81·17 per cent. absorbed.

(3) The Absorption of the Nitrogen of Arhar Dal *plus* Vegetables.

SERIAL No. 67.

If we substitute the value found for the absorption of the nitrogen of wheat in each of the observations, Nos. 63, 64 and 66, we obtain the percentage absorption of the nitrogen of arhar dal plus vegetables. Thus :—

(*a*) No. 63. . Wheat 11½ chittacks . 10·1545 grms. nitrogen
Arhar 2 „ . 4·0384 „ „
Vegetables 3 „ . 0·50 „ „
} shows 10·9101 grms. absorbed.

i.e., 10·1545 × 71·4 + 4·5384 grms. nitrogen (arhar + vegetables) = 10·9101 grms.

Therefore, 4·5384 grms. nitrogen (arhar+vegetables) = 10·9101— 7·2503 = 3·6598 grms.

Therefore, the nitrogen of arhar dal plus vegetables shows 80·6 per cent. absorbed.

(*b*) No. 64. . Wheat 14 chittacks . 12·362 grms. nitrogen
Arhar 2 „ . 4·0384 „ „
Vegetables 3 „ . 0·50 „ „
} shows 12·4864 grms. absorbed.

i.e., 12·362 × 71·4 + 4·5384 grms. nitrogen of (arhar + vegetables) =12·4864 grms.

Therefore, 4·5384 grms. nitrogen (arhar+vegetables)=12·4864 −8·8274 = 3·6590 grms.

Therefore, the nitrogen of arhar plus vegetables shows 80·6 per cent. absorbed.

(*c*) No. 66.	Wheat	11½	chittacks	10·1545	grms.	nitrogen	shows 12·5491 grms. absorbed.
	Arhar	3	„	6·0576	„	„	
	Vegetables	3	„	0·50	„	„	

i.e., 10·1545×71·4+6·5576 grms. nitrogen (arhar+ vegetables)=12·5491 grms.

Therefore, 6·5576 grms. nitrogen (arhar + vegetables) = 12·5491 −7·2503 = 5·2988 grms.

Therefore, the nitrogen of (arhar + vegetables) shows 80·8 per cent. absorbed.

(4) The Absorption of the Nitrogen of Vegetables.

In all our observations the vegetables were kept constant in quantity and in quality throughout the series. The estimated intake of nitrogen derived from vegetables averaged 0·5 grm. This quantity, however, varied slightly above or below this figure with the type of vegetables available at the time of the experiments. In Lucknow Jail we determined the amount of nitrogen absorbed per man daily from 3 chittacks of green vegetables.

Serial No. 68.

We have found 71·4 represents the percentage absorption of nitrogen of wheat, and 81·17 represents the percentage absorption of nitrogen of arhar. Therefore, by substituting these values in each of the observations Nos. 63, 64 and 66 we obtain the amount of nitrogen derived from vegetables.

(*a*) Thus, No. 63—

Wheat	11½	chittacks	10·1545	grms.	nitrogen	shows 10·9101 grms. absorbed.
Arhar	2	„	4·0384	„	„	
Vegetables	3	„	0·50	„	„	

i.e., 10·1545×71·4 + 4·0384×81·17 + 0·5 grms. vegetables = 10·9101 grms. Therefore, 0·5 grm. nitrogen of vegetables shows 10·9101 — 10·5283= 0·3818 grms. absorbed.

Therefore, the nitrogen of vegetables shows 76·3 per cent. absorbed.

(*b*) No. 64—

Wheat	14 chittacks	12·362 grms. nitrogen	}	shows 12·4864 grms. absorbed.
Arhar	2 „	4·0384 „ „		
Vegetables	3 „	0·50 „ „		

i.e., 12·362×71·4 + 4·0384×81·17 + 0·5 grm. vegetables = 12·4864 grms. Therefore, 0·5 grm. nitrogen of vegetables] shows 12·4864—12·1044= 0·3820 grms. absorbed.

Therefore, the nitrogen of vegetables shows 76·4 per cent. absorbed.

(*c*) No. 66—

Wheat	11½ chittacks	10·1545 grms. nitrogen	}	shows 12·5491 grms. absorbed.
Arhar	3 „	6·0576 „ „		
Vegetables	3 „	0·50 „ „		

i.e., 10·1545×71·4 + 6·0576×81·17 + 0·5 grm. nitrogen of vegetables = 12·5491 grms. Therefore, 0·5 grm. nitrogen of vegetables=12·5491—12·1672 =0·3619 grms. absorbed.

Therefore, the nitrogen of vegetables shows 76·3 per cent. absorbed.

(5) The Absorption of the Nitrogen of Gram Dal.

Four prisoners under observation for six days.

Wheat	11½ chittacks.
Gram	3½ „
Vegetables	3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Vegetables.
2nd March 1910	89·00	16·33	10·1545	5·8758	0·5
3rd March 1910	85·00	17·67	10·1545	5·8758	0·5
4th March 1910	96·50	18·41	10·1545	5·8758	0·5
5th March 1910	113·50	22·53	10·1545	5·8758	0·5
6th March 1910	62·5	14·71	10·1545	5·8758	0·5
7th March 1910	95·5	21·14	10·1545	5·8758	0·5
8th March 1910	32·5	8·54	10·1545	5·8758	0·5

Average intake of nitrogen per man daily . . . 16·5303 grms.

Average output of nitrogen in fæces per man daily . . 4·9271 grms.

Nitrogen absorbed—11·5582 grms.=69·9 per cent. of nitrogen of diet.

Now by introducing the values found for the absorption of the nitrogen of wheat and vegetables we obtain the percentage of the nitrogen of gram absorbed. Thus :—

10·1545×71·4+5·8758 grms. nitrogen of gram + 0·5×76·3 = 11·5582 grms. Therefore, 5·8758 grms. nitrogen of gram = 11·5582—7·6318 grms.= 3·9264 grms.

Therefore, the nitrogen of gram shows 66·8 per cent. absorbed.

SERIAL No. 70. BATCH B.

Five prisoners under observation for six days.

Wheat . . . . . 11½ chittacks.
Gram . . . . . 2 „
Vegetables . . . . . 3 „

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Vegetables.
2nd March 1910 . . .	55·50	10·71	10·1545	3·3576	0·5
3rd March 1910 . . .	75·50	21·53	10·1545	3·3576	0·5
4th March 1910 . . .	65·50	20·47	10·1545	3·3576	0·5
5th March 1910 . . .	97·50	23·91	10·1545	3·3576	0·5
6th March 1910 . . .	81·50	21·88	10·1545	3·3576	0·5
7th March 1910 . . .	76·50	17·35	10·1545	3·3576	0·5
8th March 1910 . . .	25·50	9·29	10·1545	3·3576	0·5

Average intake of nitrogen per man daily . . . 14·0121 grms.

Average output of nitrogen in fæces per man daily . . 4·1713 grms.

Nitrogen absorbed—9·8408 grms.=70·2 per cent of nitrogen of diet.

By introducing as in No. 69 the values for the absorption of the nitrogen of wheat and vegetables we obtain the percentage of the nitrogen of gram absorbed. Thus :—

10·1545×71·4 + 3·3576 grms. nitrogen of gram + 0·5×76·3 = 9·8408 grms.

Therefore, 3·3576 grms. nitrogen of gram = 9·8408—7·6318 = 2·2090 grms.

Therefore, the nitrogen of gram shows 65·7 per cent. absorbed.

SERIAL No. 71.

By taking these two last observations, Nos. 69 and 70, together we find that a difference of 1½ chittacks of gram, or 2·5182 grms. nitrogen, causes a difference of 11·5582—9·8408 grms. = 1·7174 grms.

Therefore, the nitrogen of gram shows 68·2 per cent. absorbed.

(6) The Absorption of the Nitrogen of a different Wheat.

SERIAL No. 72.

Five prisoners under observation for five days.

Wheat	11½ chittacks.
Gram	2½ ,,
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
17th March 1910	94·00	20·52	10·028	4·197	1·9184	0·5
18th March 1910	97·50	21·76	10·028	4·197	1·9184	0·5
19th March 1910	117·00	26·87	10·028	4·197	1·9184	0·5
20th March 1910	119·00	24·63	10·028	4·197	1 9184	0·5
21st March 1910	93·50	21·41	10·028	4·197	1·9184	0·5
22nd March 1910	43·00	14·39	10·028	4·197	1·9184	0·5

Average intake of nitrogen per man daily . . . 16·6434 grms.

Average output of nitrogen in fæces per man daily . . . 5·1432 grms.

Nitrogen absorbed—11·5002 grms. = 69·1 per cent. of nitrogen of diet.

Now by introducing our known factors for the absorption of the nitrogen of gram, arhar and vegetables, we obtain the percentage absorption of the nitrogen from this sample of wheat. Thus: —

10·028 grms. nitrogen of wheat $+4·197 \times 66·8 + 1·9184 \times 81·17 + 0·5 \times 76·3 = 11·5002$ grms.

Therefore, 10·028 grms. nitrogen of wheat = 11·5002—4·7424 grms. = 6·7596 grms.

Therefore, this sample of wheat shows 67·5 per cent. of its nitrogen absorbed.

(7) The Absorption of the Nitrogen of Barley.

SERIAL No. 73. BATCH C.

Five prisoners under observation for six days.

Wheat	3 chittacks.
Barley	11 ,,
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
2nd March 1910. .	71·50	17·84	2·649	9·678	2·0192	0·5
3rd March 1910. .	114·50	26·20	2·649	9·678	2·0192	0·5
4th March 1910. .	104·00	22·90	2·649	9·678	2·0192	0·5
5th March 1910 .	87·50	23·20	2·649	9·678	2·0192	0·5
6th March 1910. .	108·50	30·77	2·649	9·678	2·0192	0·5
7th March 1910. .	94·50	23·37	2·649	9·678	2·0192	0·5
8th March 1910. .	29·00	12·27	2·649	9·678	2·0192	0·5

Average intake of nitrogen per man daily . . . 14·8462 grms.

Average output of nitrogen in fæces per man daily . . 5·2183 grms.

Nitrogen absorbed—9·6279 grms.=64·8 per cent. of nitrogen of diet.

By introducing the known values for the absorption of wheat, arhar and vegetables, we can obtain the percentage of the absorption of the nitrogen of barley. Thus:—

2·649×71·4+9·678 grms. nitrogen of barley+2·5192×80·6=9·6279 grms.

Therefore, 9·678 grms. nitrogen of barley=9·6279—3·9217 grms.=5·7062 grms. absorbed.

Therefore, the nitrogen of barley shows 58·9 per cent. absorbed.

Serial No. 74. Batch C.

Five prisoners under observation for five days.

Wheat	8 chittacks.
Barley	5 ,,
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. ozs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
10th March 1910 .	79·50	18·23	7·064	4·39	2·0192	0·5
11th March 1910 .	81·00	19·70	7·064	4·39	2·0192	0·5
12th March 1910 .	104·50	23·00	7·064	4·39	2·0192	0·5
13th March 1910 .	62·20	14·90	7·064	4·39	2·0192	0·5
14th March 1910 .	98·00	23·75	7·064	4·39	2·0192	0·5
15th March 1910 .	22·50	8·67	7·064	4·39	2·0192	0·5

Average intake of nitrogen per man daily . . . 13·9732 grms.

Average output of nitrogen in fæces per man daily . . 4·330 grms.

Nitrogen absorbed—9·6432 grms.=69·0 per cent. of nitrogen of diet.

By introducing the same factors as in No. 73 for the values of the absorption of the nitrogen of wheat, arhar and vegetables, we can obtain the percentage of the nitrogen of barley absorbed. Thus :—

7·064 × 71·4+4·39 grms. nitrogen of barley +2·5192 × 80·6=9·6432 grms.

Therefore, 4·39 grms. nitrogen of barley shows 9·6432—7·0740 grms.= 2·5692 grms. absorbed.

Therefore, the nitrogen of barley shows 58·5 per cent. absorbed.

Serial No. 75. Batch D.

Five prisoners under observation for five days.

Wheat	8 chittacks.
Barley	6 ,,
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. ozs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Barley.	Nitrogen of Arhar.	Nitrogen of Vegetables.
10th March 1910	72·50	14·70	7·064	5·268	2·0192	0·5
11th March 1910	107·50	23·78	7·064	5·268	2·0192	0·5
12th March 1910	105·50	23·85	7·064	5·268	2·0192	0·5
13th March 1910	112·50	25·67	7·064	5·268	2·0192	0·5
14th March 1910	120·50	20·08	7·064	5·268	2·0192	0·5
15th March 1910	30·00	8·50	7·064	5·268	2·0192	0·5

Average intake of nitrogen per man daily . . . 14·8512 grms.

Average output of nitrogen in fæces per man daily . . 4·6624 grms.

Nitrogen absorbed—10·1888 grms.=68·6 per cent. of nitrogen of diet.

By introducing the same factors as in Nos. 73 and 74 for the value of the absorption of the nitrogen of wheat, arhar dal and vegetables, we can obtain the percentage of the nitrogen of barley absorbed. Thus :—

7·064 × 71·4+5·268 grms. nitrogen of barley+2·5192 × 80·6=10·1888 grms.

Therefore, 5·268 grms. nitrogen of barley=10·1888—7·0740 grms.=3·1148 grms. absorbed.

Therefore, the nitrogen of barley shows 59·1 per cent. absorbed.

(8) The Absorption of the Nitrogen of Juar.

Serial No. 76.

Five prisoners under observation for five days.

Wheat	6 chittacks.
Juar	7 „
Arhar	2 „
Vegetables	3 „

	Total amount of fæces. ozs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Arhar.	Nitrogen of Vegetables.
17th March 1910	69·50	19·97	5·298	5·208	4·0384	0·5
18th March 1910	83·50	24·15	5·298	5·208	4·0384	0·5
19th March 1910	67·00	20·52	5·298	5·208	4·0384	0·5
20th March 1910	75·00	21·51	5·298	5·208	4·0384	0·5
21st March 1910	75·00	24·66	5·298	5·208	4·0384	0·5
22nd March 1910	29·50	14·05	5·298	5·208	4·0384	0·5

Average intake of nitrogen per man daily . . . 15·0444 grms.

Average output of nitrogen in fæces per man daily . . 4·9944 grms.

Nitrogen absorbed—10·05 grms. = 66·8 per cent. of nitrogen of diet.

By introducing the figures obtained for the absorption of the nitrogen of wheat, arhar and vegetables, we can find the percentage of the nitrogen of juar absorbed. Thus: —

5·298 × 71·4+5·208 grms. nitrogen of juar+4·5384 × 80·8=10·05 grms.

Therefore, 5·208 grms. nitrogen of juar=10·05—7·4407 grms.=2·6093 grms. absorbed.

Therefore, the nitrogen of juar shows 50·1 per cent. absorbed.

SUMMARY OF RESULTS OBTAINED IN LUCKNOW JAIL.

(1) The co-efficient of the absorption of ordinary jail wheat—

From Nos. 63, 64 and 65, the absorption works out to be 71·4 per cent.

(2) The absorption of the nitrogen of arhar dal—

From Nos. 63 and 66, the absorption works out to be 81·17 per cent.

(3) The absorption of the nitrogen of arhar dal plus vegetables—

From Nos. 63, 64 and 66, the absorption works out to be 80·6 per cent.

(4) The absorption of the nitrogen of vegetables—

From Nos. 63, 64 and 66, the absorption works out to be 76·3 per cent.

(5) The absorption of the nitrogen of gram dal—

From No. 69, the absorption works out to be 66·8 per cent.
„ 70 „ „ „ „ 65·7 „ „
„ 71 „ „ „ „ 68·2 „ „

(6) The absorption of the nitrogen of another sample of wheat—

From No. 72, the absorption works out to be 67·5 per cent.

(7) The absorption of the nitrogen of barley—

From No. 73, the absorption works out to be 58·9 per cent.
„ 74 „ „ „ „ 58·5 „ „
„ 75 „ „ „ „ 59·1 „ „

(8) The absorption of the nitrogen of juar—

From No. 76, the absorption works out to be 50·1 per cent.

Therefore, for all practical purposes the percentages of the absorption of the nitrogen of the food-stuffs investigated in Lucknow Central Jail are:—

1.	Ordinary jail wheat, 1st sample	71·4 per cent.
2.	„ „ „ 2nd „	67·5 „
3.	Arhar dal	81·17 „
4.	Arhar dal *plus* vegetables	80·6 „
5.	Vegetables	76·3 „
6.	Gram dal	66·9 „
7.	Barley	58·8 „
8.	Juar	50·1 „

Contrasting these results with the percentages of the absorption of nitrogen found for the food-stuffs in use in Benares Jail, it will be evident that, with the exception of barley and gram, the percentages absorbed are on a lower level. The outstanding difference is met with in contrasting the absorption of the nitrogen of the first quality of wheat in Benares Jail and the average sample in use in Lucknow.

First quality wheat of Benares gave 80·5 per cent. absorption, while the best we obtained for Lucknow only showed 71·4 per cent. absorption. The absorption of nitrogen from the inferior qualities of wheat works out to be much the same in the two jails, *viz.*, 68·8 per cent. in Benares Jail and 67·5 per cent. in Lucknow.

There is little doubt but that the high level of nitrogen absorption obtained for first class wheat is intimately connected with the high protein content of the sample.

1 oz. of first class Benares wheat contains 0·5354 grm. nitrogen.

1 oz. of the average sample of wheat in use in Benares and Lucknow Jails contains 0·4630 grm. nitrogen.

The first class wheat shows 80·5 per cent. of its nitrogen absorbed, while the average ordinary jail wheat in use in Lucknow and Benares only shows 69·2 per cent. absorbed. As has already been pointed out, there appears to be always an admixture of other cereals, and particularly barley, in even the best samples of wheat obtained. In the poorer samples of wheat all manner of grains are to be found, more especially barley, gram, maize, etc. : some of them will tend to raise the protein content of the sample while decreasing the relative absorption, while some will tend to lower the protein content and decrease the relative absorption at the same time. This being the case the percentage of protein shown by a sample may be no measure of the percentage of nitrogen absorbed from that sample. In the majority of fairly clean samples, however, the contamination is mainly due to barley, the greater portion of the other grains being got rid of during the cleaning process, so that the tendency is for a fall in protein content to be accompanied by a fall in the percentage of nitrogen absorbed.

With regard to the higher figures obtained for the absorption of the nitrogen of barley and gram dal in Lucknow Jail and in Benares the chemical analyses throws some light. Thus :—

1 oz. gram,	Lucknow,	contains	0·9401	grm.	nitrogen	66·9	per cent.	absorption.
1 „ „	Benares,	„	0·8222	„	„	61·3	„	„
1 „ barley,	Lucknow,	„	0·4390	„	„	58·8	„	„
1 „ „	Benares,	„	0·3725	„	„	56·4	„	„

Any admixture of gram dal will usually be with another pulse, which will have the effect of raising the protein content of the sample and increasing the percentage of nitrogen absorbed. The reason of this is that gram contains the lowest percentage of protein and is the most difficult of absorption of all the pulses : so that, any admixture with another pulse will tend to increase both. With regard to barley the commonest foreign element seen is wheat which will have a tendency to raise both the protein content and the relative absorption. While this it true in a general way, it will be easily understood that foreign grains may be present in samples of any of the food-stuffs which may increase the percentage of protein shown by the sample and yet decrease considerably the value of the sample, so far as the absorption of protein is concerned.

Arhar dal and vegetables with 80·6 per cent. absorption, Lucknow, and juar with 50·1 per cent. absorption, Lucknow, are lower than was found for the absorption of the nitrogen of these food-materials in Benares Jail.

As the food-materials worked with in Benares Jail were selected and fairly pure, the results obtained in that jail may be accepted as the standard

of what good class food-stuffs should be and the nitrogen absorption they should show. We present these results in tabular form and give the corresponding results for Lucknow food-stuffs :—

Food-materials.	Benares Jail.	Lucknow Jail.
First quality wheat . . .	80·5 per cent.	...
Ordinary jail wheat . . .	68·8 „ „	71·4 per cent.
„ „ „ . . .	...	67·5 „ „
Gram dal	61·3 per cent.	66·9 „ „
Arhar dal *plus* vegetables . .	84·0 „ „	80·6 „ „
Arhar dal	...	81·17 „ „
Juar	54·4 per cent.	50·1 „ „
Barley	56·4 „ „	58·8 „ „
Bajra	49·3 „ „	...
Vegetables	...	76·3 per cent.

D.—AGRA CENTRAL JAIL.

We now come to the consideration of the work carried out in Agra Jail. Here it was found to be practically impossible to obtain pure samples of wheat, even the best obtainable being only slightly superior to the ordinary wheat in use in Benares Jail. On analysis, however, it gave a slightly higher protein content than the wheat in ordinary use in Lucknow Jail.

1 oz. 1st class Benares wheat contains	. .	0·5354	grms. nitrogen.
„ Ordinary „ „ „	. .	0·4858	„ „
„ 1st class Agra „ „	. .	0·4896	„ „
„ Ordinary „ „ „	. .	0·4536	„ „

The first class Benares wheat was pure and contained very few foreign elements, so that its protein content may be taken as approximately the amount that a good sample should give. A greater or less departure from this standard does not necessarily mean a greater or less admixture with foreign grains ; as it would be quite possible to obtain a sample of wheat which would reach this standard and yet be very largely mixed with foreign grains, any lowering brought about by the presence of materials having a lower protein content being compensated for by the presence of materials having a higher protein content. It will be evident, therefore, that no reliance can be placed on the gross chemical composition of a food-stuff as a measure or criterion of its real nutritive value, and that the only true measure of the value of a food-material, so far as its protein is concerned, is the percentage absorption of nitrogen possible from it.

(1) The absorption of the Nitrogen of the Ordinary Jail Wheat.

Serial No. 77.

Five prisoners under observation for seven days.

Wheat	11½ chittacks.
Gram	2½ ,,
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th March 1910	7·25	28·29	10·433	3·855	1·9964	0·5
19th March 1910	8·00	28·45	10·433	3·855	1·9964	0·5
20th March 1910	9·50	29·87	10·433	3·855	1·9964	0·5
21st March 1910	9·50	29·99	10·433	3·855	1·9964	0·5
22nd March 1910	7·12	23·06	10·433	3·855	1·9964	0·5
23rd March 1910	6·20	22·39	10·433	3·855	1·9964	0·5
24th March 1910	9·50	31·20	10·433	3·855	1·9964	0·5
25th March 1910	3·38	14·14	10·433	3·855	1·9964	0·5

Average intake of nitrogen per man daily . . . 16·7844 grms.

Average output of nitrogen in fæces per man daily . . 5·9254 grms.

Nitrogen absorbed—10·859 grms. = 64·7 per cent. of nitrogen of diet.

Serial No. 78.

Five prisoners under observation for seven days.

Wheat	10 chittacks.
Gram	2½ ,,
Arhar	1 chittack.
Vegetables	3 chitetcks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th March 1910 .	6·40	26·35	9·072	3·855	1·9964	0·5
19th March 1910 .	6·50	26·77	9·072	3·855	1·9964	0·5
20th March 1910 .	5·60	22·70	9·072	3·855	1·9964	0·5
21st March 1910 .	6·70	25·88	9·072	3·855	1·9964	0·5
22nd March 1910 .	5·12	21·90	9·072	3·855	1·9964	0·5
23rd March 1910 .	8·16	30·11	9·072	3·855	1·9964	0·5
24th March 1910 .	5·34	20·28	9·072	3·855	1·9964	0·5
25th March 1910 .	3·60	15·84	9·072	3·855	1·9964	0·5

Average intake of nitrogen per man daily . . . 15·4234 grms.

Average output of nitrogen in fæces per man daily . . 5·4237 grms.

Nitrogen absorbed—9·9997 grms.=64·8 per cent. of nitrogen of diet.

Serial No. 79.

By taking these two observations together we see that a difference of $1\frac{1}{2}$ chittacks of wheat, or 1·361 grms. nitrogen, causes a difference of 0·8593 grms.

Therefore, 1,361 grms. nitrogen of wheat=0·8593 grms. absorbed.

Therefore, the nitrogen of wheat shows 63·1 per cent. absorbed.

Serial No. 80.

Five prisoners under observation for seven days.

Wheat	$13\frac{1}{2}$ chittacks.
Gram	$2\frac{1}{2}$ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th March 1910 .	6·06	25·12	12·2472	3·855	1·9964	0·5
19th March 1910 .	10·80	35·85	12·2472	3·855	1·9964	0·5
20th March 1910 .	11·40	38·26	12·2472	3·855	1·9964	0·5
21st March 1910 .	7·95	25·45	12·2472	3·855	1·9964	0·5
22nd March 1910 .	8·56	29·10	12·2472	3·855	1·9964	0·5
23rd March 1910 .	10·10	33·67	12·2472	3·855	1·9964	0·5
24th March 1910 .	9·06	30·80	12·2472	3·855	1·9964	0·5
25th March 1910 .	3·53	12·32	12·2472	3·855	1·9964	0·5

Average intake of nitrogen per man daily . . . 18·5986 grms.

Average output of nitrogen in fæces per man daily . . 6·5877 grms.

Nitrogen absorbed—12·0109 grms.=64·6 per cent. of nitrogen of diet.

SERIAL NO. 81.

By taking this observation in conjunction with Nos. 77 and 78, we can obtain the absorption of the nitrogen of wheat. Thus:—

(*a*) In conjunction with No. 77, we find that an increase of 2 chittacks of wheat, or 1·8142 grms. nitrogen, is accompanied by an increase of 12·0109 grms.—10·859 grms.=1·1519 grms. nitrogen.

Therefore, 1·8142 grms. nitrogen of wheat show 1·1519 grms. nitrogen absorbed.

Therefore, wheat has 63·5 per cent. of its nitrogen absorbed.

(*b*) In conjunction with No. 78, we find that an increase of 3½ chittacks of wheat, or 3·1752 grms. nitrogen, is accompanied by an increase of 12·0109—9·9997 grms. =2·0112 grms.

Therefore, 3·1752 grms. nitrogen of wheat show 2·0112 grms. absorbed.

Therefore, wheat shows 63·3 per cent. of its nitrogen absorbed.

Therefore, we may accept the average of Nos. 79 and 81, 63·3 per cent., as the absorption of the nitrogen of this sample of wheat.

(2) The Absorption of the Nitrogen of Arhar Dal *plus* Vegetables.

SERIAL NO. 82.

Five prisoners under observation for four days.

Wheat	11½ chittacks.
Arhar	2 ,,
Vegetables	3 ,,

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Arhar.	Nitrogen of Vegetables.
26th March 1910	8·00	20·62	10·433	3·9928	0·5
27th March 1910	7·94	25·70	10·433	3·9928	0·5
28th March 1910	5·25	18·74	10·423	3·9928	0·5
29th March 1910	5·12	18·19	10·433	3·9928	0·5
30th March 1910	4·32	17·25	10·433	3·9928	0·5

Average intake of nitrogen per man daily . . 14·9258 grms.

Average output of nitrogen in fæces per man daily . . 5·025 grms.

Nitrogen absorbed—9·9008 grms. =66·3 per cent. of nitrogen of diet.

We know from other observations that 63·3 per cent. of the nitrogen of wheat is absorbed, therefore, by introducing this value for the nitrogen of wheat we can obtain the percentage of nitrogen of arhar *plus* vegetables absorbed. Thus :—

10·433 × 63·3 + 4·4928 grms. nitrogen (arhar + vegetables) = 9·9008 grms.

Therefore, 4·4928 grms. nitrogen (arhar + vegetables) = 9·9068 — 6·604 grms. = 3·2968 grms.

Therefore, the nitrogen of arhar *plus* vegetables shows 73·4 per cent. absorbed.

(3) The Absorption of the Nitrogen of Gram Dal.

SERIAL NO. 83.

We know that 63·3 per cent. of the nitrogen of wheat is absorbed.

And that 73·4 per cent. of the nitrogen of arhar dal *plus* vegetables is absorbed.

By substituting these factors in Nos. 77, 78 and 80, we obtain the percentage of nitrogen absorbed from gram. Thus :—

(*a*) No. 77.	Wheat	11½ chittacks	10·433 grms.	nitrogen	shows 10·859 grms. nitrogen absorbed.
	Gram	2½ „	3·855 „	„	
	Arhar	1 chittack	1·9964 „	„	
	Vegetables	3 chittacks	0·50 „	„	

i.e., 10·433 × 63·3 + 3·855 grms. nitrogen of gram + 2·4964 × 73·4 = 10·859 grms.

Therefore, 3·855 grms. nitrogen of gram = 10·859 — 8·4363 grms. = 2·4227 grms.

Therefore, the nitrogen of gram shows 62·8 per cent. absorbed.

(*b*) No. 78.	Wheat	10 chittacks	9·072 grms.	nitrogen	shows 9·9997 grms. absorbed.
	Gram	2½ „	3·855 „	„	
	Arhar	1 chittack	1·9964 „	„	
	Vegetables	3 chittacks	0·50 „	„	

i.e., 9·072 × 63·4 + 3·855 grms. nitrogen of gram + 2·4964 × 73·4 = 9·9997 grms.

Therefore, 3·855 grms. nitrogen of gram = 9·9997 — 7·5748 grms. = 2·4249 grms.

Therefore, the nitrogen of gram shows 62·9 per cent. absorbed.

(*c*) No. 80.	Wheat	13½ chittacks	12·2472 grms.	nitrogen.	shows 12·109 grms. absorbed.
	Gram	2½ „	3·8550 „	„	
	Arhar	1 chittack	1·9904 „	„	
	Vegetables	3 chittacks	0·50 „	„	

i.e., 12·2472 × 63·3 + 3·855 grms. nitrogen of gram + 2·4964 × 73·4 = 12·0109 grms.

Therefore, 3·855 grms. nitrogen of gram = 12·0109 − 9·5847 grms. = 2·4262 grms.

Therefore, the nitrogen of gram shows 62·9 per cent. absorbed.

(4) The Absorption of the Nitrogen of First Quality Wheat.

SERIAL NO. 84.

Five prisoners under observation for seven days.

1st class Wheat	11½ chittacks.
Gram	3½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
18th March 1910 .	3·75	15·31	11·2608	5·397	1·9964	0·5
19th March 1910 .	6·72	28·96	11·2608	5·397	1·9964	0·5
20th March 1910 .	8·95	25·34	11·2608	5·397	1·9964	0·5
21st March 1910 .	6·35	28·23	11·2608	5·397	1·9964	0·5
22nd March 1910 .	8·72	32·56	11·2608	5·397	1·9964	0·5
23rd March 1910 .	6·12	26·42	11·2608	5·397	1·9964	0·5
24th March 1910 .	6·63	27·35	11·2608	5·397	1·9964	0·5
25th March 1910 .	4·10	18·10	11·2608	5·397	1·9964	0·5

Average intake of nitrogen per man daily . . . 19·1542 grms.

Average output of nitrogen in fæces per man daily . . 5·7791 grms.

Nitrogen absorbed—13·3751 grms. = 69·8 per cent. of nitrogen of diet.

By substituting the known values for the absorption of the nitrogen of gram, arhar and vegetables, we obtain the percentage of the nitrogen of this sample of wheat absorbed.

i.e., 11·2608 grms. nitrogen of wheat = 13·3751 − 5·397 × 62·9 − 2·4964 × 73·4

= 13·3751 − 5·227 = 8·1481

Therefore, the nitrogen of this wheat shows 72·3 per cent. absorbed.

(1) The Absorption of the Nitrogen of Ordinary Jail Wheat.

Serial No. 85.

Five prisoners under observation for four days.

Wheat	7	chittacks.
Juar	5	„
Urid dal	2	„
Gram	2	„
Vegetables	3	„

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Urid.	Nitrogen of Gram.	Nitrogen of Vegetables.
26th March 1910 . .	8·06	33·86	6·3504	3·402	4·196	3·084	0·5
27th March 1910 . .	7·56	32·03	6·3504	3·402	4·196	3·084	0·5
28th March 1910 . .	8·90	37·39	6·3504	3·402	4·196	3·084	0·5
29th March 1910 . .	4·56	21·85	6·3504	3·402	4·196	3·084	0·5
30th March 1910 . .	4·00	20·50	6·3504	3·402	4·196	3·084	0·5

Average intake of nitrogen per man daily . . 17·5324 grms.

Average output of nitrogen in fæces per man daily . . 7·2815 grms.

Nitrogen absorbed—10·2509 grms.=58·4 per cent. of nitrogen of diet.

Serial No. 86.

Five prisoners under observation for five days.

Wheat	5	chittacks.
Juar	5	„
Urid dal	2	„
Gram	2	„
Vegetables	3	„

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Urid.	Nitrogen of Gram.	Nitrogen of Vegetables.
26th March 1910 .	8·38	29·41	4·536	3·402	4·196	3·084	0·5
27th March 1910 .	7·60	25·42	4·536	3·402	4·196	3·084	0·5
28th March 1910 .	7·80	31·14	4·536	3·402	4·196	3·084	0·5
29th March 1910 .	8·63	32·86	4·536	3·402	4·196	3·084	0·5
30th March 1910 .	3·00	13·41	4·536	3·402	4·196	3·084	0·5

Average intake of nitrogen per man daily . . 15·718 grms.

Average output of nitrogen in fæces per man daily . . 6·612 grms.

Nitrogen absorbed—9·106 grms.=57·9 per cent. of nitrogen of diet.

SERIAL No. 87.

By taking these two observations, Nos. 85 and 86, together we find that a difference of 2 chittacks of wheat causes a difference of 10·2509 − 9·106 grms. = 1·1449 grms.

Therefore, 1·8144 grms. nitrogen of wheat = 1·1449 grms. absorbed.

Therefore, the nitrogen of wheat shows 63·1 per cent. absorbed, a result corresponding very closely with that already obtained in previous observations.

The very large quantity of nitrogen passed in the fæces with a correspondingly poor absorption in Nos. 85 and 86 should be noted. This type of diet is most unsuitable.

(5) The Absorption of the Nitrogen of Juar.

SERIAL No. 88.

Five prisoners under observation for four days.

Wheat	5 chittacks.
Juar	7 „
Urid	2 „
Gram	2 „
Vegetables	3 „

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Urid.	Nitrogen of Gram.	Nitrogen of Vegetables.
26th March 1910	7·00	25·31	4·536	4·7628	4·196	3·084	0·5
27th March 1910	8·53	32·47	4·536	4·7628	4·196	3·084	0·5
28th March 1910	7·25	25·08	4·536	4·7628	4·196	3·084	0·5
29th March 1910	2·31	40·65	4·536	4·7628	4·196	3·084	0·5
30th March 1910	4·06	20·99	4·536	4·7628	4·196	3·084	0·5

Average intake of nitrogen per man daily . . . 17·0783 grms.

Average output of nitrogen in fæces per man daily . . 7·275 grms.

Nitrogen absorbed—9·8038 grms. = 55·9 per cent. of nitrogen of diet.

SERIAL No. 89.

By taking the two observations, Nos. 86 and 88, together we find that 2 chittacks of juar, or 1·3608 grms. nitrogen, cause an increase in the amount of nitrogen absorbed by 9·8038—9·106 grms.

Therefore, 1·3608 grms. nitrogen of juar show 0·6978 grms. absorbed.

Therefore, the nitrogen of juar shows 51·3 per cent. absorption.

(6) The Absorption of the Nitrogen of Urid Dal *plus* Vegetables.

SERIAL NO. 90.

We have learned that the average absorption of the nitrogen of ordinary wheat in Agra Jail is 63·25 per cent., and gram 62·9 per cent. and juar 51·3 per cent.

By substituting these values in each of the observations Nos. 85, 86 and 88 we can obtain the percentage absorption of the nitrogen of urid dal *plus* vegetables.

To obtain the average of the three observations we may add them together and then substitute. Thus:—

No. 85 Wheat	7 chittacks	. 6·3504 grms.	nitrogen	} 15·4224 grms.
No. 86 „	5 „	. 4·5360 „	„	
No. 88 „	5 „	. 4·5360 „	„	
No. 85 Juar	5 „	. 3·4020 „	„	} 11·5668 grms.
No. 86 „	5 „	. 3·4020 „	„	
No. 88 „	7 „	. 4·7628 „	„	

Nos. 85, 86, and 88, Urid dal 2 chittacks 4·196 × 3 grms. nitrogen . . . . . 12·588 grms.

Nos. 85, 86, and 88, Gram dal 2 chittacks 3·084 × 3 grms. nitrogen . . . . . 9·252 grms.

Nos. 85, 86, and 88, Vegetables 3 chittacks 0·5 × 3 grms. nitrogen . . . . . 1·50 grms.

i.e., 15·4224 × 63·25+11·5668 × 51·3+12·588 grms. nitrogen of urid+9·252 × 62·9+1·5 grms. nitrogen of vegetables=10·2509+9·106+9·8038=29·1607 grms.

Therefore, 12·588 grms. nitrogen of urid+1·5 grms. nitrogen of vegetables= 29·1607—21·5078=7·6529 grms.

Therefore, 14·085 grms. nitrogen (urid+vegetables) =7·6529 grms.

Therefore, the nitrogen of urid+vegetables shows 54·3 per cent. absorbed.

(7) The Absorption of the Nitrogen of Arhar Dal.

SERIAL NO. 91.

Five prisoners under observation for four days.

Juar	11 chittacks.
Urid	8 „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Juar.	Nitrogen of Urid.	Nitrogen of Arhar.	Nitrogen of Vegetables.
26th March 1910 .	8·00	30·92	7·4844	6·294	1·9964	0·5
27th March 1910 .	12·72	49·27	7·4844	6·294	1·9964	0·5
28th March 1910 .	8·40	34·99	7·4844	6·294	1·9964	0·5
29th March 1910 .	12·28	43·21	7·4844	6·294	1·9964	0·5
30th March 1910 .	6·70	23·50	7·4844	6·294	1·9964	0·5

Average intake of nitrogen per man daily . . . 16·2748 grms.

Average output of nitrogen in fæces per man daily . . 7·2756 grms.

Nitrogen absorbed—8·9992 grms. = 55·3 per cent. of nitrogen of diet.

Now substitute the known values for the absorption of the nitrogen of juar, urid dal and vegetables, and we can obtain the percentage of the nitrogen of arhar dal absorbed. Thus :—

$7{\cdot}4844 \times 51{\cdot}3 + (6{\cdot}294 + 0{\cdot}5) \times 54{\cdot}3 + 1{\cdot}9964$ grms. nitrogen of arhar $= 8{\cdot}9992$ grms.

Therefore, 1·9964 grms. nitrogen of arhar = 8·9992—7·529 grms.

Therefore, the nitrogen of arhar shows 73·6 per cent. absorbed.

It will be evident from the observations, Nos. 85, 86, 88 and 91, how very great the quantity of nitrogen passed in the fæces works out to be. While this is to be explained to some extent by the inferiority of the food-stuffs in use, there is no doubt but that the excessive quantity of pulses in the diets in question has a marked influence. On an average over the four diets, fully half the nitrogen of the intake is derived from two of the dals, and there can be little doubt but that the optimum amount of these food-stuffs has been passed in these diets. This probably accounts for the very low figure obtained for the absorption of the nitrogen of urid dal and even arhar in the last recorded observation, No. 91.

This finishes our observations in Agra Central Jail, that were carried out in March 1910. A few observations, however, were made in October 1909. The food-stuffs in use in October gave practically identical analyses with those in use in March of the following year. Let us examine the nitrogen absorption shown by the different food-materials.

October 1909.

AGRA CENTRAL JAIL.

(1) The Absorption of the Nitrogen of Wheat.

SERIAL No. 92.

Ten prisoners under observation for ten days.

Wheat	13 chittacks.
Gram	2½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
8th November 1909 .	8·90	641·20 grms.	11·8048	3·855	1·939	0·5
9th November 1909 .	14·25		11·8048	3·855	1·939	0·5
10th November 1909 .	13·00		11·8048	3·855	1·939	0·5
11th November 1909 .	11·50		11·8048	3·855	1·939	0·5
12th November 1909 .	13·00		11·8048	3·855	1·939	0·5
13th November 1909 .	12·60		11·8048	3·855	1·939	0·5
14th November 1909 .	13·00		11·8048	3·855	1·939	0·5
15th November 1909 .	10·25		11·8048	3·855	1·939	0·5
16th November 1909 .	12·25		11·8048	3·855	1·939	0·5
17th November 1909 .	12·20		11·8048	3·855	1·939	0·5

Average intake of nitrogen per man daily . . . 18·0988 grms.

Average output of nitrogen in fæces per man daily . . 6·4120 grms.

Nitrogen absorbed—11·6868 grms. = 64·6 per cent. of nitrogen of diet.

SERIAL No. 93.

Ten prisoners under observation for six days.

Wheat	10 chittacks.
Gram	2½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
26th October 1909 .	6·75	324·30 grms.	9·072	3·855	1·939	0·5
27th October 1909 .	9·75		9·072	3·855	1·939	0·5
28th October 1909 .	9·25		9·072	3·855	1·939	0·5
29th October 1909 .	9·75		9·072	3·855	1·939	0·5
30th October 1909 .	10·25		9·072	3·855	1·939	0·5
31st October 1909 .	9·75		9 072	3·855	1·939	0·5

Average intake of nitrogen per man daily . . . 15·366 grms.

Average output of nitrogen in fæces per man daily . . 5·405 grms.

Nitrogen absorbed—9·961 grms. = 64·8 per cent. of nitrogen of diet.

Serial No. 94.

By taking these two observations, Nos. 92 and 93, together we learn that a difference of 3 chittacks of wheat, or 2·7328 grms. nitrogen, causes a difference of 11·6868 — 9·961 grms. = 1·7258 grms.

Therefore, 2·7328 grms. nitrogen of wheat show 1·7258 grms. absorbed.

Therefore, the nitrogen of wheat shows 63·2 per cent. absorbed, a result corresponding very closely with that obtained later.

(2) The Absorption of the Nitrogen of Arhar Dal *plus* Vegetables.

Serial No. 95.

By adding together Nos. 92 and 93 we get the absorption of nitrogen over a large number of days, and obtain a good average.

No. 92 13 chittacks Wheat . . 11·8048 grms. nitrogen
„ 93 10 „ „ . . 9·0720 „ „
} 20·8768 grms. nitrogen.

Nos. 92 and 93 Gram 2½ chittacks 3·855 grms. nitrogen × 2 = 7·710 grms. nitrogen.
„ 92 „ 93 Arhar 1 chittack 1·939 „ „ × 2 = 3·878 „ „
„ 92 „ 93 Vegetables 3 chittacks 0·5 grm. „ × 2 = 1·0 „ „

Therefore 20·8768 grms. nitrogen of Wheat .
7·710 „ „ „ Gram .
3·878 „ „ „ Arhar .
1·00 grm. „ „ Vegetables .
} show 21·6478 grms. nitrogen absorbed.

Now substitute the values for the absorption of the nitrogen of wheat, 63·2 per cent., and for gram, 62·9 per cent., and we get the percentage of the nitrogen of arhar dal *plus* vegetables absorbed.

i.e., 20·8768 × 63·2 + 7·710 × 62·9 = 21·6478 − 4·878 grms. nitrogen (arhar + vegetables).

Therefore, 4·878 grms. nitrogen (arhar + vegetables) = 21·6478 − 18·0434 = 3·6044 grms.

Therefore, the nitrogen of arhar dal *plus* vegetables shows 73·8 per cent. absorbed which is practically identical with that observed later in the year.

(Gram, as it was identical in analysis with that worked with in March 1910, has been taken as showing a similar percentage of its nitrogen absorbed.)

(3) The Absorption of the Nitrogen of Juar.

SERIAL No. 96.

Ten prisoners under observation for ten days.

Wheat	. . . . .	5¾ chittacks.
Juar	. . . . .	5½ „
Gram	. . . . .	2¾ „
Arhar	. . . . .	1 chittack.
Vegetables	. . . . .	3 chittacks.

	Total amount of fæces. lbs.	Total Nitrogen of fæces.	Nitrogen of Wheat.	Nitrogen of Juar.	Nitrogen of Gram.	Nitrogen of Arhar.	Nitrogen of Vegetables.
12th October 1910 .	14·75	588·57 grms.	5·2187	3·993	4·2405	1·939	0·5
13th October 1910 .	11·75		5·2187	3·993	4·2405	1·939	0·5
14th October 1910 .	12·14		5·2187	3·993	4·2405	1·939	0·5
15th October 1910 .	8·50		5·2187	3·993	4·2405	1·939	0·5
16th October 1910 .	11·50		5·2187	3·993	4·2405	1·939	0·5
17th October 1910 .	7·25		5·2187	3·993	4·2405	1 939	0·5
18th October 1910 .	10·50		5·2187	3·993	4·2405	1·929	0·5
19th October 1910 .	11·00		5·2187	3·993	4·2405	1·935	0·5
20th October 1910 .	12·75		5·2187	3·993	4·2405	1·939	0·5
21st October 1910 .	9·50		5·2187	3·993	4·2405	1·939	0·5

Average intake of nitrogen per man daily . . 15·8912 grms.

Average output of nitrogen in fæces per man daily . . 5·8857 grms.

Nitrogen absorbed—10·0055 grms. = 62·9 per cent. of nitrogen of diet.

By substituting our known factors for the absorption of the nitrogen of—

Wheat, 63·2 per cent.

Gram, 62·9 per cent.

Arhar dal and vegetables, 73·8 per cent.

we obtain the amount of nitrogen absorbed from the juar.

Thus :—

5·2187 × 63·2 + 3·993 grms. nitrogen of juar + 4·2405 × 62·9 + 2·439 × 73·8 = 10·0055 grms.

Therefore, 3·993 grms. nitrogen of juar = 10·0055 — 7·7653 grms. = 2·2402 grms.

Therefore, the nitrogen of juar shows 56·1 per cent. absorbed.

This is distinctly a higher value than that obtained for the absorption of the nitrogen of juar in March 1910, which was 51·3 per cent. It may be that the difference in the protein content of the two samples accounts for the variation found in the nitrogen absorption.

October 1909. 1 oz. juar contains 0·363 grm. nitrogen and shows 56·1 per cent. absorbed.
March 1910. „ „ „ 0·3402 „ „ „ 51·3 „ „ „

SUMMARY OF RESULTS OBTAINED IN AGRA JAIL.

1. The co-efficient of the absorption of nitrogen of first quality wheat—

From Serial Number 84 the absorption works out to be 72·3 per cent.

2. The absorption of the nitrogen of the ordinary jail wheat—

From Nos. 77, 78 and 79 the absorption works out to be 63·1 per cent.
„ „ 77, 78, 80 and 81 „ „ „ „ 63·5 „
„ „ 77, 78, 80 and 81 „ „ „ „ 63·3 „
„ „ 85, 86, and 87 „ „ „ „ 63·1 „
„ „ 92, 93 and 94 „ „ „ „ 63·2 „

3. The absorption of the nitrogen of arhar dal *plus* vegetables—

From No. 82 the absorption works out to be . . 73·4 per cent.
„ „ 95 „ „ „ „ . . 73·8 „

4. The absorption of the nitrogen of gram dal—

From No. 83 in conjunction with—

No. 77 the absorption works out to be . . . 62·8 per cent.
„ 78 „ „ „ „ . . . 62·9 „
„ 80 „ „ „ „ . . . 62·9 „

5. The absorption of the nitrogen of juar—

From Nos. 86, 88 and 89 the absorption works out to be 51·3 per cent.

6. The absorption of the nitrogen of a different sample of juar—

From No. 96 the absorption works out to be 56·1 per cent.

7. The absorption of the nitrogen of urid dal *plus* vegetables—

From No. 90 in conjunction with the observations, Nos. 85, 86 and 88, the absorption works out to be 54·3 per cent.

8. The absorption of the nitrogen of arhar dal—

From No. 91 the absorption works out to be 73·6 per cent.

Therefore, for all practical purposes we may accept the following as being the percentages of the nitrogen of the different food-stuffs of Agra Jail that are absorbed :—

1. First quality wheat	. . . .	72·3 per cent.
2. Ordinary jail wheat	. . . . .	63·24 „
3. Arhar dal *plus* vegetables	. . . .	73·6 „
4. Gram dal	. . . . .	62·9 „
5. Juar 1st sample	. . . . .	51·3 „
6. „ 2nd „	. . . . .	56·1 „
7. Urid dal *plus* vegetables	. . . .	54·3 „
8. Arhar dal	. . . . .	73·6 „

Wheat is by far the most important of the food-materials in use in the jail dietaries of the United Provinces, so that any inferiority in the material supplied is at once reflected in the level of nitrogenous interchange possible with the diets containing it. This is very markedly the case in the Agra results, the absorption of nitrogen from the diets and the level of nitrogenous metabolism attained by the prisoners being on a lower scale than was the case with prisoners investigated in other jails.

The absorption of nitrogen shown by the ordinary sample of wheat in daily use in Agra Jail is very low and compares very unfavourably with the absorption of the first quality of wheat in Benares Jail, or even with the absorption from the ordinary jail material of Naini, Benares and Lucknow.

The best quality of wheat we could obtain gave a co-efficient of nitrogen absorption very little higher than that of the ordinary wheat of Benares and

Lucknow Jails. We may contrast the protein content of this sample with that of wheat, experimented with in Benares, Naini, and Lucknow Jails.

1 oz. first quality Benares wheat	contains	0·5354	grm.	nitrogen	80·5	per cent.	absorbed.
1 oz. „ „ Agra	„	0·4896	„	„	72·3	„	„
1 oz. ordinary jail wheat, Naini	„	0·4710	„	„	68·8	„	„
1 oz. average jail wheat in use in Benares and Lucknow	„	0·4630	„	„	69·2	„	„

It would therefore appear that a relationship does exist between the protein content of a sample and the percentage absorption from that sample. While this may be true for samples that are fairly clean and pure, or in which the only or chief foreign element is barley, it does not hold good for all classes of wheat, nor where the contaminating factors are of various kinds. Thus :—

1 oz. ordinary Agra	wheat contains	0·4536	grm.	nitrogen	63·3	per cent.	absorbed.
1 oz. „ Lucknow	„	0·4360	„	„	67·5	„	„
1 oz. „ „	„	0·4415	„	„	71·4	„	„

so that, though the ordinary sample of Agra wheat contains a higher percentage of nitrogen than either of the Lucknow samples, yet it is accompanied by a percentage of absorption considerably lower than was found for the Lucknow wheats.

We believe the explanation of the fact, that Agra wheat shows a fair protein content with a poor absorption of its nitrogen while Lucknow wheat with a lower protein content shows a higher percentage absorption of its nitrogen, to be that in the Agra wheat contaminating elements are present, which, though yielding a large amount of nitrogen on analysis, are incapable, or only partially capable, of being absorbed by the intestinal tract.

The absorption shown by the other food-materials examined are all on a lower level than in either Benares or Lucknow Jails. This is particularly noticeable with regard to the absorption of the nitrogen of arhar dal and arhar dal *plus* vegetables. The absorption from urid dal *plus* vegetables is also very poor and compares very badly with that obtained for it in Naini Jail. It is probable, however, that the poor absorption of nitrogen from urid dal is to be accounted for, to some extent, by the excessive quantities of pulse in the diets investigated. These diets are, however, made use of in the feeding of the prisoners and the pulses are often given in very large quantities when bajra, juar, or barley forms the principal of the diet. It is important, therefore, to know how very inferior the absorption of nitrogen is from diets of the type in which the principal source of protein is from the pulses, *i.e.*, diets in which the principal being poor in protein an effort is made to bring the diet up to the supposed proper standard by increasing the quantity of pulse to an excessive degree.

GENERAL SUMMARY OF WORK ON NITROGEN ABSORPTION.

We are now in a position to work out the averages of the absorption of the nitrogen shown by the different food-stuffs investigated in these large jails :—

	Benares.	Naini.	Lucknow.	Agra.	Average absorption.
1st quality wheat . . .	80·6	...	...	...	80·6
„ „ „ . . .	...	...	...	72·3	72·3
Ordinary jail wheat . . .	68·8	68·8	71·4	63·3	67·1
„ „ „ . . .	...	62·8	67·5		
Arhar dal *plus* vegetables . .	84·0	83·8	80·6	73·6	80·5
Gram dal	61·3	65·7	66·9	62·9	64·2
Urid dal	...	69·2	...	...	69·2
Urid dal *plus* vegetables . .	...	...	...	54·3	54·3
Arhar dal	...	...	81·17	73·6	77·4
Barley	56·4	...	58·8	...	57·6
Juar	54·4	...	50·1	51·3	53·0
„	...	...	...	56·1	
Bajra	49·3	49·4	...	...	49·4
Vegetables	...	...	76·3	...	76·3

(NOTE.—Column 5 of our table gives the average absorption of nitrogen in percentages. Urid dal *plus* vegetables is probably too low, as the pulses were excessive in the diets from which this result was obtained. Arhar dal is also too low an average for the whole province, as arhar dal shows higher results in Benares and Naini Jails. The average for arhar dal *plus* vegetables is, however, sufficient.)

We have seen that the diet most commonly in use in the different jails of the Province is—

		Average value in nitrogen.
Wheat	. 11½ chittacks . . .	. 10·67 grms.
Gram	. 2½ „	. 3·97 „
Arhar	. 1 chittack	. 2·42 „
Vegetables	. 3 chittacks . . .	.

If we make use of these averages of the percentages of nitrogen absorption for the different constituents, it will be found that this diet shows an average level of nitrogenous metabolism of 11·656 grms. of nitrogen per man daily. This is practically identical with the results obtained from actual observations carried out with Diet E of the Jail Code, as will be found under serial numbers 1 to 7 with summary. In those investigations we found the average level of nitrogenous interchange possible from this diet to be 11·6499 grms. of nitrogen per man daily.

This completes the investigations on the absorption of nitrogen of the different food-materials entering into the dietaries of the United Provinces. We have nothing further to add except again to point out that, wheat being the most important element in the dietaries, the level of nitrogenous interchange will mainly depend on the purity of the particular sample of wheat in use.

With good quality of wheat the nitrogenous absorption from dietaries in which wheat forms the principal source of nitrogen is over 80 per cent., and thus compares very favourably with what has been observed in European vegetarian dietaries. When wheat is contaminated with other grains the absorption of nitrogen necessarily falls and the level of nitrogenous interchange is lowered.

In connection with the values we found for the co-efficient of protein absorption for the food-materials in use in the jails of the United Provinces, the following results obtained from digestion experiments on the Japanese[1] are of interest :—

CO-EFFICIENT OF DIGESTIBILITY.

Experiment No.	Food.	Protein.	Carbohydrate.
1	Barley, cooked .	. 40·2 per cent. (*a*)	90·9 per cent. (*a*)
2	Ditto .	. 51·9 „ „	95·0 „ „
3	Ditto .	. 48·6 „ „	94·5 „ „
114	Rolled barley, cooked	. 76·4 „ „	97·9 „ „
117	Cracked barley, cooked	. 62·2 „ „	99·4 „ „
	Average . .	. 59·8 „ „	96·7 „ „
75	Buck wheat . .	. 74·3 „ „	96·8 „ „
76	Ditto . .	. 76·3 „ „	97·2 „ „
	Average . .	. 75·3 „ „	97·0 „ „
6	Beans, dried .	. 61·8 „ „	81·4 „ „
7	Ditto .	. 69·1 „ „	89·9 „ „
	Average . .	. 65·5 „ „	85·7 „ „
Average for vegetables	.	. 72·3 „ „	88·0 „ „

(*a*) Accuracy uncertain and not included in average.

The averages of these values for protein absorption are very similar to what we have found for similar food-materials in India.

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[1] A Digest of Japanese Investigations on the Nutrition of Men. By Kintaro Oshima. U. S. Dept. of Agr. Bull. No. 159.

The following figures for the digestibility of legumes obtained in America[1] are also of interest :—

Co-efficient of Digestibility.

Average of Experiments.	Food.	Protein.	Carbohydrates.
8	Kidney beans .	. 77 per cent.	94 per cent.
6	White „ .	. 78 „ „	96 „ „
12	Whippoorwill peas .	. 70 „ „	87 „ „
9	Clay peas . .	. 74 „ „	88 „ „
14	Lady peas . .	. 83 „ „	95 „ „

In all cases the legumes were cooked in the same way, hence the results with the different legumes are directly comparable.

The co-efficients of protein absorption for the different legumes of America are not very dissimilar to what we have found for the pulses in the jail dietaries of the United Provinces.

[1] Studies on the Digestibility and Nutritive Value of Legumes. By Charles Wait. U. S. Dept. of Agr. Bull. 187.

CHAPTER V.

The Determination of the Co-efficients of Absorption of the Carbohydrates offered in the Food-Stuffs entering into the Jail Dietaries of the United Provinces.

So far in these researches we have dealt entirely with the absorption of protein, hardly mentioning the carbohydrates and fats. Protein is admittedly of pre-eminent importance in a diet ; as it is from protein alone that the nitrogenous tissues of the body are built up and repaired, the protein of a diet cannot, therefore, be replaced by any other aliment. The dietaries of the jails of the United Provinces, being entirely derived from the vegetable kingdom, are not likely to be deficient in carbon if the nitrogenous principles are present in sufficient amount. Reference to our analyses of the several dietaries in force will show that the carbohydrates, offered the prisoners in the jails of the United Provinces, are well in excess of the quantities generally accepted as sufficient for Europeans of a much greater body-weight than attained by the average native of the United Provinces. So that, the carbohydrates per kilo of body-weight offered in the jail dietaries of the United Provinces are very much greater than are to be found in even Moleschott's or any of the standard dietaries framed for Europeans. We shall have something to say with regard to this peculiarity of these jail dietaries when discussing their suitability, at present our enquiry is directed to the absorption of carbohydrates possible from dietaries of this type.

When discussing the carbohydrates of the Bengal jail dietaries,[1] we pointed out " that abundant experimental evidence had accumulated to show that the nutritive values of fat and carbohydrates are practically proportional to the amount of energy they furnish ; consequently it was only important that the quantity of either or both be such that their total energy, when added to that of the protein of the diet, shall supply the amount required by the body. The maximum amount of energy that can be obtained by the body is not the total potential energy of the food consumed, since the potential energy of the corresponding fæces must be deducted. Furthermore, the body is not capable of completely oxidising the absorbed protein, the incompletely oxidised products being excreted in the urine, and the energy eliminated in this way must also be deducted. The net or actual energy-value of the food to the body is the total potential energy *minus* that of the corresponding urine and fæces.[2]" In dealing, however, with the vegetarian dietaries in force in Indian jails another factor has to be considered with regard to the energy or fuel value of a diet : this factor is the excessive fermentative processes taking place in the

[1] Scientific Memoirs, No. 37.

[2] The nutritive requirements of the body. Benedict, Am. Jour. of Physiology, Vol. XVI, No. IV.

digestive tract, which constitutes an important source of loss of potential energy of the diets, through the conversion of sugar or starch into carbon dioxide, methane, hydrogen, acetic acid, lactic acid, butyric acid, etc., and other fermentative products of low caloric value. We brought forward evidence to show that this was, in all probability, a serious source of loss of the total potential energy of the Bengal diet and would account for the seemingly high percentage of carbohydrate absorption shown by Bengali prisoners. We did not carry out many observations on the absorption of carbohydrates from Bengal Jail dietaries, but those that were made pointed undoubtedly to a very trifling elimination of carbohydrates in the fæces.

We have entered into this subject in more detail in our observations on the jail dietaries of the United Provinces, and have again found that the carbohydrates of the fæces form a very small proportion of the total carbohydrates intake. Whether this means an actual high percentage of carbohydrate absorption, or only an apparently high percentage of absorption, from the breaking up of starch and sugars by intestinal fermentation into products of little value, is an open question. In our opinion the inhabitant of the United Provinces does not exhibit signs and symptoms of gastro-intestinal fermentation to anything like the same extent as met with in the Bengali. The fæces while often soft and voluminous are usually well-formed and seldom so light in colour as in the Bengali.

Colic, diarrhœa, gastro-intestinal catarrh and particularly dysentery are not nearly so prevalent in the jails of the United Provinces as in Bengal Jails. However, there can be little doubt but that a good deal more fermentation does take place than would be normally the case if the dietaries conformed more to the carbohydrate standard of Europe.

We shall now proceed to give an account of the work done on the absorption of carbohydrates exhibited by the prisoners of the jails of the United Provinces. As Diet E of the Jail Code is the only one used practically all over the Province, we estimated the carbohydrate absorption from this diet.

1.—The average amount of Carbohydrates absorbed from the Jail Dietaries of the United Provinces.

Diet E.

Wheat	11½ chittacks	or 23 ozs.	roughly.
Gram dal	2½ „	„ 5 „	„
Arhar	1 chittack „	2 „	„
Vegetables	3 chittacks „	6 „	„

I.—AGRA CENTRAL JAIL. BATCH A.

Serial No. 97.

Five prisoners under observation for seven days.

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	lbs.	Grms.	Grms.	Grms.	Grms.	Grms.
18th March 1910 .	7·25	63	484·48	73·39	31·31	25·50
19th March 1910 .	8·00	113	484·48	73·39	31·31	25·50
20th March 1910 .	9·50	183	484·48	73·39	31·31	25·50
21st March 1910 .	9·50	162	484·48	73·39	31·31	25·50
22nd March 1910 .	7·12	47	484·48	73·39	31·31	25·50
23rd March 1910 .	6·20	81	484·48	73·39	31·31	25·50
24th March 1910 .	9·50	131	484·48	73·39	31·31	25·50
25th March 1910 .	3·38	46	484·48	73·39	31·31	25·50

Average intake of carbohydrates per man daily . . 614·68 grms.

Average output of carbohydrates in fæces per man daily . . . 23·6 grms.

Carbohydrates absorbed — 591·08 grms. = 96·2 per cent. of the carbohydrates of the diet.

II.—LUCKNOW CENTRAL JAIL. BATCH B.

Serial No. 98.

Five prisoners under observation for five days.

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	ozs.	Grms.	Grms.	Grms.	Grms.	Grms.
17th March 1910 .	94·00	110	484·48	73·39	31·31	25·50
18th March 1910 .	97·50	97	484·48	73·39	31·31	25·50
19th March 1910 .	117·00	83	484·48	73·39	31·31	25·50
20th March 1910 .	119·00	146	484·48	73·39	31·31	25·50
21st March 1910 .	93·50	41	484·48	73·39	31·31	25·50
22nd March 1910 .	43·00	30	484·48	73·39	31·31	25·50

Average intake of carbohydrates per man daily . . . 614·68 grms.

Average output of carbohydrates in fæces per man daily . . . 20·28 grms.

Carbohydrates absorbed — 594·40 grms. = 96·7 per cent. of the carbohydrates of the diet.

Therefore, accepting the average value of Diet E in carbohydrate to be 614·68 grms., the average absorption is 592·74 grms., or 96·4 per cent.

It will be evident from these results that the loss of sugar-forming substances in the fæces is very small compared with what was found to be the waste of protein materials. The absorption of protein exhibited by these same batches of prisoners on the same diets was 64·7 per cent. and 69·1 per cent. respectively. It would therefore appear that the carbohydrates of the diet are very much better absorbed than the protein; however, it has been already pointed out that while only a trifling amount of sugar-forming materials may be passed in the fæces, this is no proof that the absorption of carbohydrates is as high as it seems to be, as fermentation in the bowel may break up a considerable amount of the carbohydrates into bodies from which sugar cannot be obtained by hydrolysis. That is, carbohydrates may disappear in the bowel without either being absorbed as sugar or passed out in the fæces as sugar-forming material, while protein, on the other hand, is incapable of being so dissipated. Protein can neither be lost nor manufactured in the bowel by putrefaction of the intestinal contents; so that, we have in the estimation of the protein of the fæces a true measure of the loss of protein to the system, while the estimation of the carbohydrates of the fæces may not be any index of the extent of carbohydrate absorption.

However, with this reservation as to the true interpretation of the results, we may say that apparently a very high percentage absorption — 96·4 — is shown by the carbohydrate element of the most commonly used diet of the jails of the United Provinces.

II.—The Co-efficient of Absorption of the Carbohydrates of Wheat.

We have learned from Serial No. 97 that a diet composed of—

Wheat	11½ chittacks	484·48 grms.	carbohydrate.
Gram	2½ „	73·39 „	„
Arhar	1 chittack	31·31 „	„
Vegetables . . .	3 chittacks	25·50 „	„

shows 591·08 grms. carbohydrates absorbed.

Now increase the quantity of wheat to 13½ chittacks, and decrease it to 10 chittacks and note results. Thus :—

AGRA JAIL.

SERIAL NO. 99.

Five prisoners under observation for seven days.

Wheat	13½ chittacks.
Gram	2½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	lbs.	Grms.	Grms.	Grms.	Grms.	Grms.
18th March 1910 .	6·06	96	563·86	73·39	31·31	25·50
19th March 1910 .	10·80	115	563·86	73·39	31·31	25·50
20th March 1910 .	11·40	88	563·86	73·39	31·31	25·50
21st March 1910 .	7·95	72	563·86	73·39	31·31	25·50
22nd March 1910 .	8·56	130	563·86	73·39	31·31	25·50
23rd March 1910 .	10·10	166	563·86	73·39	31·31	25·50
24th March 1910 .	9·06	184	563·86	73·39	31·31	25·50
25th March 1910 .	3·53	84	563·86	73·39	31·31	25·50

Average intake of carbohydrates per man daily . . 699·06 grms. Average output of carbohydrates in fæces per man daily . . . 26·7 grms.

Carbohydrate absorption — 672·36 grms. = 96·2 per cent. of the carbohydrates of the diet.

Serial No. 100.

Five prisoners under observation for seven days.

Wheat . . . . . 10 chittacks.
Gram . . . . . 2½ „
Arhar . . . . . 1 chittack.
Vegetables . . . . . 3 chittacks.

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	lbs.	Grms.	Grms.	Grms.	Grms.	Grms.
18th March 1910 .	6·40	133	421·38	73·39	31·31	25·50
19th March 1910 .	6·50	63	421·38	73·39	31·31	25·50
20th March 1910 .	5·60	64	421·38	73·39	31·31	25·50
21st March 1910 .	6·70	94	421·38	73·39	31·31	25·50
22nd March 1910 .	5·12	63	421·38	73·39	31·31	25·50
23rd March 1910 .	8·16	192	421·38	73·39	31·31	25·50
24th March 1910 .	5·34	125	421·38	73·39	31·31	25·50
25th March 1910 .	3·60	22	421·38	73·39	31·31	25·50

Average intake of carbohydrates per man daily . . 551·59 grms. Average output of carbohydrates in fæces per man daily . . . 21·6 grms.

Carbohydrates absorbed — 529·98 grms. = 96 per cent. of the carbohydrates of the diet.

SERIAL No. 101.

By taking the observations, Nos. 97, 99 and 100 in pairs, we can obtain figures giving the percentage absorption of the carbohydrates of wheat.

Thus (*a*) From Nos. 97 and 99 we see that a difference of 2 chittacks of wheat, or 84·38 grms. of carbohydrates, causes a decrease of 672·36—591·08 grms. = 81·28 grms. in absorption.

Therefore, the carbohydrate of wheat shows 96·3 per cent. absorbed.

(*b*) From Nos. 97 and 100 we see that a difference of 1½ chittacks of wheat, or 63·1 grms. carbohydrate, causes a decrease of 591·08 — 529·98 grms. = 61·10 grms. in absorption.

Therefore, the carbohydrate of wheat shows 96·8 per cent. absorbed.

(*c*) From Nos. 99 and 100 we learn that a difference of 3½ chittacks of wheat, or 147·48 grms. carbohydrates, causes a decrease of 672·36 — 529·98 grms. = 142·38 grms. in absorption.

Therefore, the carbohydrate of wheat shows 96·5 per cent. absorbed.

Averaging these results we may accept the co-efficient of the absorption of the carbohydrates of wheat to be 96·5 per cent.

III.—The Co-efficient of Absorption of the Carbohydrates of Gram Dal.

We know from No. 97 that a diet composed of—

Wheat	11½ chittacks	484·48 grms. carbohydrate.	shows 591·08 grms. carbohydrates absorbed.
Gram	2½ „	73·39 „ „	
Arhar	1 chittack	31·31 „ „	
Vegetables	3 chittacks	25·50 „ „	

Now decrease the quantity of gram and note the effect. Thus :—

SERIAL No. 102.

Five prisoners under observation for seven days.

Wheat	11½ chittacks.
Gram	1½ „
Arhar	1 chittack.
Vegetables	3 chittacks

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	lbs.	Grms.	Grms.	Grms.	Grms.	Grms.
18th March 1910 .	5·35	81	484·48	44·03	31·31	25·50
19th March 1910 .	8·01	124	484·48	44·03	31·31	25·50
20th March 1910 .	7·25	112	484·48	44·03	31·31	25·50
21st March 1910 .	9·44	159	484·48	44·03	31·31	25·50
22nd March 1910 .	4·53	58	484·48	44·03	31·31	25·50
23rd March 1910 .	8·83	106	484·48	44·03	31·31	25·50
24th March 1910 .	6·25	80	484·48	44·03	31·31	25·50
25th March 1910 .	4·40	83	484·48	44·03	31·31	25·50

Average intake of carbohydrates per man daily . . . 585·32 grms. Average output of carbohydrates in fæces per man daily . . 22·94 grms.

Carbohydrates absorbed — 562·38 grms. =96 per cent. of the carbohydrates of the diet.

Now by taking this result with that of No. 97, we see that a difference of 1 chittack of gram dal, or 29·36 grms. of carbohydrate, causes a difference of 28·70 grms. absorbed.

i.e., 591·08 — 562·38 = 28·70 grms. in absorption.

Therefore, the carbohydrate of gram dal shows 97·7 per cent. absorbed.

IV.—The Co-efficient of Absorption of the Carbohydrates of Arhar Dal *plus* Vegetables.

SERIAL NOS. 103.

Having found the co-efficient of carbohydrate absorption of wheat to be 96·50 per cent., and the co-efficient of carbohydrate absorption of gram to be 97·7 per cent., by substituting these values in any or all of the observations Nos. 97, 98, 99, 100 and 102 we get the value of the co-efficient of carbohydrate absorption of arhar dal *plus* vegetables.

SERIAL NUMBERS.	Carbohydrates of Wheat.	Carbohydrates of Gram.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.	Absorbed.
	Grms.	Grms.	Grms.	Grms.	Grms.
97	484·48	73·39	31·31	25·50	591·08
98	484·48	73·39	31·31	25·50	594·40
99	568·86	73·39	31·31	25·50	672·36
100	421·38	73·39	31·31	25·50	529·98
102	484·48	44·03	31·31	25·50	562·38
TOTAL .	2,443·68	337·59	156·55	127·50	2,950·20

i.e., 2,443·68 × 96·5 + 337·59 × 97·7 + 284·05 (arhar + vegetables) = 2,950·20 grms.

Therefore, 2,358·15 + 329·82 + 284·05 (arhar + vegetables) = 2,950·20 grms.

Therefore, 284·05 (arhar+vegetables)=2,950·20—2,687·97 grms.=262·23 grms.

Therefore, the carbohydrates of arhar dal *plus* vegetables show 92·3 per cent. absorption.

LUCKNOW JAIL.

V.—The Co-efficient o Absorption of the Carbohydrates of Arhar Dal.

Serial No. 104.

Five prisoners under observation for five days.

Wheat	11½ chittacks.
Arhar	2 „
Vegetables	3 „

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	ozs.	Grms.	Grms.	Grms.	Grms.
10th March 1910	72·00	73	484·48	62·62	25·50
11th March 1910	71·00	97	484·48	62·62	25·50
12th March 1910	92·50	84	484·48	62·62	25·50
13th March 1910	76·50	40	484·48	62·62	25·50
14th March 1910	95·00	86	484·48	62·62	25·50
15th March 1910	31·00	20	484·48	62·62	25·50

Average intake of carbohydrates per man daily . . . 572·60 grms.

Average output of carbohydrates in fæces per man daily . . 16·00 grms.

Carbohydrates absorbed — 556·60 grms.=97·2 per cent. of the carbohydrates of the diet.

Serial No. 105.

Four prisoners under observation for five days.

Wheat	11½ chittacks.
Arhar	3 „
Vegetables	3 „

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	ozs.	Grms.	Grms.	Grms.	Grms.
17th March 1910	45·50	28	484·48	93·93	25·50
18th March 1910	60·50	43	484·48	93·93	25·50
19th March 1910 . . .	75·00	80	484·48	93·93	25·50
20th March 1910	58·00	96	484·48	93·93	25·50
21st March 1910 . . .	80·20	59	484·48	93·93	25·50
22nd March 1910	24·35	34	484·48	93·93	25·50

Average intake of carbohydrates per man daily . . 603·91 grms. Average output of carbohydrates in fæces per man daily . . 17·00 grms.

Carbohydrates absorbed — 586·91 grms. = 97·1 per cent. of the carbohydrates of the diet.

Serial No. 106.

By taking Nos. 104 and 105 together we learn that the difference of 1 chittack of arhar dal, or 31·31 grms. carbohydrate, causes a difference of 586·91—556·60 grms. absorption = 30·31 grms.

Therefore, the carbohydrates of arhar dal show 96·8 per cent. absorbed.

VI.—The Co-efficient of Absorption of the Carbohydrates of Barley.

Serial No. 107.

Five prisoners under observation for five days.

Wheat	8 chittacks.
Barley	5 „
Arhar	1 chittack.
Vegetables	3 chittacks.

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Arhar.	Carbohydrates of Barley.	Carbohydrates of Vegetables.
	ozs.	Grms.	Grms.	Grms.	Grms.	Grms.
10th March 1910 .	79·50	82	337·03	31·31	221·21	25·50
11th March 1910 .	81·00	91	337·03	31·31	221·21	25·50
12th March 1910 .	104·50	93	337·03	31·31	221·21	25·50
13th March 1910 .	62·20	86	337·03	31·31	221·21	25·50
14th March 1910 .	98·00	124	337·03	31·31	221·21	25·50
15th March 1910 .	22·50	18	337·03	31·31	221·21	25·50

Average intake of carbohydrates per man daily . . 615·05 grms. Average output of carbohydrates in fæces per man daily . . . 19·76 grms.

Carbohydrates absorbed — 595·29 grms. = 96·8 per cent. of the carbohydrates of the diet.

We know from Nos. 104 and 105 that 97·2 per cent. of the carbohydrates of a diet of wheat, arhar and vegetables is absorbed, therefore, by substituting this value, we can obtain the percentage absorption of the carbohydrates of barley. Thus :—

(337·03+31·31+25·50)×97·2+221·21 grms. carbohydrates of barley =595·29 grms.

Therefore, 221·21 grms. carbohydrates of barley=595·29—382·81 grms.

Therefore, 221·21 grms. carbohydrates of barley show 212·48 grms. absorbed.

Therefore, the carbohydrates of barley show 96 per cent. absorbed.

VII.—The Co-efficient of Absorption of the Carbohydrates of Jaur.

SERIAL No. 108.

Five prisoners under observation for five days.

Wheat	. . . . .	6 chittacks.
Juar	. . . . .	7 „
Arhar	. . . . .	2 „
Vegetables	. . . . .	3 „

	Total amount of fæces.	Carbohydrates of fæces.	Carbohydrates of Wheat.	Carbohydrates of Juar.	Carbohydrates of Arhar.	Carbohydrates of Vegetables.
	ozs.	Grms.	Grms.	Grms.	Grms.	Grms.
17th March 1910 .	92·50	106	252·77	273·72	62·62	25·50
18th March 1910 .	123·50	74	252·77	273·72	62·62	25·50
19th March 1910 .	122·00	61	252·77	273·72	62·62	25·50
20th March 1910 .	96·50	52	252·77	273·72	62·62	25·50
21st March 1910 .	98·00	65	252·77	273·72	62·62	25·50
22nd March 1910 .	25·50	25	252·77	273·72	62·62	25·50

Average intake of carbohydrates per man daily . . 614·61 grms. Average output of carbohydrates in fæces per man daily . . 15·32 grms.

Carbohydrates absorbed — 599·29 grms. = 97·5 per cent. of the carbohydrates of the diet.

Now substitute, as in No. 107, for the known absorption of the carbohydrates of wheat, arhar and vegetables and we obtain the percentage of absorption of the carbohydrates of juar. Thus :—

(252·77+62·62+25·50) × 97·2+273·72 grms. carbohydrates of juar =599·29 grms. absorbed.

Therefore, 273·72 grms. carbohydrates of juar=599·29—331·34 grms. =267·95 grms.

Therefore, the carbohydrates of juar show 97·8 per cent. absorbed.

This completes the observations we are able to publish on the estimations of the carbohydrates eliminated in the fæces. Many other batches of prisoners on different diets were investigated from this standpoint, but owing usually to breakages of the flasks during hydrolysis and consequent loss of the sample of fæces, the period of observation was broken and the work done rendered practically useless. In no series of observations, however, did we ever find any large proportion of carbohydrates passed in the fæces; the ordinary run of the figures working out, for the absorption of the carbohydrates of the different food-stuffs, at 96 to 98 per cent., even with those food-materials whose co-efficient of protein absorption had been found to be very low. It may, therefore, be accepted that the absorption of the carbohydrates of the different food-materials in use in the jail dietaries of the United Provinces ranges round 96 to 98 per cent., a figure very similar to the absorption obtained with European types of dietaries. Thus Hutchison[1] gives the absorption of the carbohydrates of cereals and sugars, 98 per cent., vegetables and fruits, 95 per cent.

SUMMARY OF THE RESULTS OBTAINED FOR THE ABSORPTION OF CARBOHYDRATES.

1. The average absorption of the carbohydrates of the jail dietaries of the United Provinces is 96·4 per cent.

2. The co-efficient of absorption of the carbohydrates of wheat works out to be 96·5 per cent.

3. The co-efficient of absorption of the carbohydrates of gram dal works out to be 97·7 per cent.

4. The co-effieient of absorption of the carbohydrates of arhar dal *plus* vegetables works out to be 92·3 per cent.

5. The co-efficient of absorption of the carbohydrates of arhar dal works out to be 96·8 per cent.

6. The co-efficient of absorption of the carbohydrates of barley works out to be 96 per cent.

7. The co-efficient of absorption of the carbohydrates of juar works out to be 97·8 per cent.

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[1] Hutchison : Food and the Principles of Dietetics.

Table showing the percentage absorption of the protein and carbohydrates of the food-materials in use in the jail dietaries of the United Provinces.

Food-stuff.	Absorption of Protein.	Absorption of Carbohydrates
Wheat	67·10 per cent.	96·50 per cent.
Arhar dal *plus* vegetables	80·50 „ „	92·30 „ „
Gram dal	64·20 „ „	97·70 „ „
Arhar dal	81 to 84 „ „	96·80 „ „
Barley	57·60 „ „	96·00 „ „
Juar	53·00 „ „	97·80 „ „
Urid dal	69·20 „ „	.....
Bajra	49·40 „ „	.....

FATS.

We made no investigations on the absorption of the fats of the jail dietaries of the United Provinces. The quantity of fat in these diets is very small and did not appear of sufficient importance to warrant special enquiry.

CHAPTER VI.

The Suitability of the Jail Dietaries of the United Provinces.

Having completed the work on the chemical examination of the food-materials, and on the level of nitrogenous and carbohydrate interchange possible from the dietaries in force, we are now in a position to discuss the suitability of those diets and point out their weaknesses. At the same time we shall endeavour to lay down the principles on which a satisfactory dietary should be founded, and the rational indications for the framing of suitable dietaries composed of the ordinary food-materials in use in the jails of the United Provinces.

Physiologically a diet may be considered from two points of view, *viz.*, its power or capability of forming new tissues or repairing waste—this will depend principally on its assimilable or available nitrogenous material; its power of yielding energy and heat—this is function of its contained protein, carbohydrate and fat. In diets wholly vegetarian in type we have besides to take into consideration the degree of waste of the most important constituent—protein—and the usually excessive caloric value exhibited by such dietaries. From the practical standpoint of cost to the State, jail dietaries should be so framed as to prevent undue waste, whilst providing a sufficiency of the different proximate principles to meet the requirements of the body.

I.—The Dietaries of the Jails of the United Provinces discussed.

In our investigation on the level of nitrogenous metabolism shown by prisoners on the different jail dietaries of the United Provinces, and on the modifications of those dietaries in which the total quantities of the different food-stuffs made up 15 chittacks, as sanctioned by the Jail Code, we learned that on an average throughout the year, prisoners were offered 16·7292 grms. nitrogen daily of which 11·286 grms., or 67·4 per cent., were absorbed. Expressed in protein this means an intake of 104·55 grms., of which 70·53 grms. undergo metabolism.

To take up the question of the sufficiency or otherwise of this quantity would be to discuss the framing of dietary standards and would lead us into controversial matter which we prefer at present to avoid. The facts as we have found them are:—

(*i*) Students and the fairly well-to-do classes in Bengal exist on a metabolism of less than 40 grms. protein daily.[1]

(*ii*) Bengali prisoners on Lower Bengal jail diets exist on a metabolism of 47·18 grms. protein daily.[2]

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[1] Scientific Memoirs No. 34.

[2] „ „ No. 37.

(*iii*) Behari prisoners on Upper Bengal jail diets exist on a metabolism of 59·37 grms. protein daily.

(*iv*) United Provinces prisoners exist on a metabolism of 70·53 grms. protein daily.

There is no doubt, therefore, but that the jail dietaries of the United Provinces are very much superior to those in use in Bengal, and seeing that the prisoners, both in Bengal and in the United Provinces, put on weight and improve physically while in jail, there can be no question of the actual sufficiency of the Bengal or United Provinces' prison fare. So far as experience goes the dietaries of the United Provinces have been in force for many years and the results have been satisfactory: in fact, in all work done so far on these diets the general opinion seems to be that the diets are excessive both in protein and carbohydrate.

Leaving aside for the present the much discussed problem of the quantity of available protein a diet should furnish, we know from practical experience that the jail dietaries of the United Provinces are sufficient for all the physiological requirements of labouring prisoners; *i.e.*, we know that dietaries furnishing 11·286 grms. of available nitrogen daily throughout the year are amply sufficient to maintain the prisoners in as good, and better, physical condition than they show either before incarceration or after release.

We may, therefore, accept this level of nitrogenous interchange as a standard to be maintained with any new scales, and search for such combinations of the several food-stuffs as will furnish this quantity and supply an adequate caloric value and will, at the same time, prevent the great loss of protein material that the present dietaries show. We have seen that on an average throughout the year only 67·4 per cent. of the total protein of the dietaries is absorbed and of any real service to the prisoners. It appears to us that this is the greatest drawback and most important weakness of the present diet scales, and that it is a rational indication to prevent as far as possible this loss to the State, while, at the same time, greatly reducing the quantity of nitrogenous matter left over for the intestinal tract to deal with. It cannot be for the welfare of the body that an average quantity of 34 grms. of protein daily should remain incapable of absorption, which, while in the bowel, provides a splendid culture medium for the growth of putrefactive micro-organisms. Any method of reducing this loss of protein will, therefore, be to the advantage of the State, in lessening the cost of the jail dietaries, and to the prisoners' advantage, in decreasing the risk of intestinal putrefaction with its attendant troubles, catarrh, diarrhœa, toxæmia, etc.

Our position, therefore, would be:—while accepting the present level or nitrogenous interchange and providing for a sufficiency of all other constituents, to modify the dietaries in force in such a way that a greater percentage

of the protein content of the diet will be absorbed and made use of in the economy.

We acknowledge at once that this means in reality to provide better diets than those at present in force, and that it shirks the important question as to whether an average level of nitrogenous metabolism of 11·286 grms. daily is not more than sufficient to meet the physiological needs of the body. Taking the average body-weight of the prisoner of the United Provinces at 54 to 56 kilos, it would mean the metabolism of 0·21 grm. of nitrogen per kilo of body-weight. Chittenden and his followers would consider anything over 0·12 grm. of nitrogen per kilo of body-weight as excessive, but we have brought forward evidence to show that this standard is probably insufficient.[1] However, there is a great difference between 0·12 grm. and 0·21 grm. of nitrogenous interchange per kilo of body-weight, and we are fully persuaded that the latter amount is a good deal in excess of the level attained by the great majority of the inhabitants of United Provinces. Personally we are of the opinion that the metabolism of 0·21 grm. of nitrogen daily per kilo of body-weight is not excessive, and that it is greatly to the advantage of the prisoner in the maintenance of his physical condition to have an adequate supply of absorbable protein. We believe, also it is to the advantage of the State that this level should not be lowered, as it ensures, in all probability, the physical fitness of the prisoners for the labour demanded and tends to lower the sickness and mortality rates.

While this is our opinion, from a physiological point of view it must be admitted that the dietaries at present in force, or any framed in future to maintain the same level, are distinctly superior to those available for the great mass of the population, and that this will tend to place a premium on crime in periods of scarcity. This, however, is a problem with which we have no concern; we simply point out its bearing in passing and leave the present policy of the maintenance of the superiority of jail dietaries, over those possible to the same classes outside the walls of the jails, to be determined by the government of the country. What we have got to deal with are the solid facts that the dietaries are at present superior inside the jail to those outside, that those dietaries permit an average level of 11·286 grms. of nitrogenous metabolism daily, and believing, as we do, that this level is not excessive, we have no physiological arguments to advance in support of any cutting down of the present scale of nitrogenous interchanges.

Therefore, taking the dietaries, as a whole, from our first point of view, *viz.*, their power or capability of forming new tissues or repairing waste, we are prepared to accept the present level of nitrogenous metabolism as a standard to

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[1] Scientific Memoirs: Nos. 34 and 37.

be maintained in the framing of new dietaries, or in any modifications of the present scales. Our reasons for so doing are :—

(*i*) We believe it is for the welfare of the prisoners and probably to the advantage of the State that the level of nitrogenous interchanges should be such as to provide liberally for the waste of every-day wear and tear.

(*ii*) It being already the policy of the Government of the country to provide dietaries that are superior inside the jail to those obtainable by the same class of people outside the jail, it is the business of the Government to determine any change in its policy : from a physiological standpoint we cannot defend any lowering of the present level.

Physiologists of the Chittenden School would hold that these dietaries are excessive and that they might be reduced all round by one-third or more with advantage. As has been already indicated also, Lewis, Macnamara, and others, from a comparison of their gross chemical composition, have shown them "to exceed under every heading the "adapted" scale prepared from English Prison Scales, and in most cases the amount of food actually issued is more than is given as a maximum dietary in either the Convict or Local Prisons of England and Wales."

While acknowledging the force of the different arguments for the reduction of the level of protein metabolism, we have had sufficient evidence in our work in India to confirm us in the opinion that a liberal supply of absorbable protein is the all-important element of a diet, without which, no matter how plentiful the other constituents may be, physical fitness, capacity for work and power of resisting disease cannot be expected.

It would, of course, be very simple for us to accept Chittenden's standard of the nitrogenous needs of the body, *viz.*, 0·12 grm. of nitrogen per kilo of body-weight, and, having already determined that the protein metabolism of the present scales provides for 0·21 grm. of nitrogen per kilo of body-weight, to reduce the several constituents of the dietaries to such an extent that Chittenden's standard would be obtained. This would mean an all-round reduction of over 40 per cent. in the food-materials offered in the present dietaries of the United Provinces, which would be a very serious step to take in the light of the present state of our knowledge regarding the nitrogenous requirements of the body, and a step which, we believe, the evidence does not warrant.

We would, therefore, prefer to work with a level of protein metabolism which has been found by practical experience to give satisfactory results, and on which the prisoners of the jails of the United Provinces keep physically fit.

Taking the dietaries, as a whole, from our second point of view, *viz.*, their power of yielding energy and heat, we are fully in agreement with the condemnation attached to diets in which the caloric value is so high. We know, of course, it is difficult to frame purely vegetarian diets which, while offering over 100 grms. of protein, will not show an excessive quantity of carbonaceous matter. Still no one could assert that a native of a hot climate, doing the very minimum of work, requires on an average over 60 calories per kilo of body-weight, while inhabitants of cold countries, like Europe and America, doing really hard work can live easily on from 40 to 45 calories per kilo of body-weight. It will be agreed, therefore, that there is room for reduction in the heat value of the dietaries. In discussing the question of how the excessive heat value of the diets of Bengal jails was dissipated, we were driven to the conclusion that neither as a source of body heat nor as a source for the energy of muscular contraction was it worked off. In all probability, as we have already intimated, a considerable amount is lost through the conversion of starch or sugar into bodies of low caloric value by intestinal fermentation. We have shown that so far as the carbohydrates are concerned the great proportion is broken up in the intestines, at least the quantity recoverable in the fæces is extremely small, being only from 2 to 4 per cent. of the total intake.

We may, therefore, conclude with regard to the heat value of the jail dietaries of the United Provinces that they offer up to 50 per cent. more calories per kilo of body-weight than the standard dietaries framed for Europeans, that the amount of energy worked off in muscular contraction is very much less than in Europeans, and that the climate being tropical, the heat requisite for the maintenance of the body temperature should be considerably less than in Europeans. In what way exactly the high potential energy of the food is dissipated we are unable to state, but it is probably that, in addition to the sources of waste already mentioned, a greater proportion is lost by radiation owing to the meagre clothing worn as compared with Europeans.

However, having taken every demand of the body for fuel into consideration, it must be admitted that the amount furnished in the jail dietaries is out of all proportion to that of the generally accepted standards. It therefore forms a weakness in the dietaries in force and will require correction, as far as possible, in any new scales suggested.

II. The individual food-materials of the Jail Dietaries of the United Provinces discussed.

Wheat is the most important of the cereals and reference to the observations on the co-efficients of absorption of its protein and carbohydrate elements

will show that, given a good clean sample, it is far superior to any of the other cereals in use. We have found that first quality wheat will have over 80 per cent. of its protein and 97 per cent. of its carbohydrates absorbed: no other cereal in use shows anything like so good results. Juar shows 53 per cent. of its protein absorbed: barley 57·6 per cent., and bajra just under 50 per cent. absorption. Another point in its favour is the fact that the relationship existing between its nitrogen and carbon elements approaches in wheat much closer than in any of the other cereals to the ratio that should hold in a satisfactory diet. For this reason good first class wheat may be looked upon as a perfect food-stuff. It is somewhat deficient in fat, but that is not a matter of serious importance so far as natives of India are concerned.

We have, therefore, in wheat of good quality an ideal food, superior in every respect to any of the other cereals of the jail dietaries of the United Provinces, and one that presents the minimum of waste of its protein element; so that diets composed largely of good wheat will leave the smallest residue of nitrogenous material to be dealt with by the intestinal tract, and offer the least opportunity for intestinal putrefaction and micro-organismal growth. Supposing for the moment that a diet composed wholly of first quality wheat exhibited the same degree of protein absorption as we have found, *viz.*, 80·6 per cent., this would mean a great superiority over the absorption attained on the average for the dietaries at present in force, *viz.*, 67·4 per cent. It would mean the reduction of the waste from over 33 per cent. to under 20 per cent.; such a reduction in the protein waste of the present diet scales would place them, physiologically, on a very different level from that which they now occupy. It would effectually correct the outstanding weakness of the present dietaries from the standpoint of the percentage of protein absorption, referred to when discussing the dietaries as a whole.

Unfortunately, when we come to analyse the results of the work on the absorption of the protein of the different samples of wheat actually in use in several jails, we find that the protein absorption falls far short of the percentage absorption shown by the first quality of wheat experimented with in Benares Jail. On an average the wheat in use in different parts of the province exhibited a protein absorption of 67·1 per cent. While this absorption is decidedly superior to what was obtained with any of the other cereals, juar, barley, or bajra, it is a serious falling off from the figure given for the protein absorption of first class material. We have already discussed at length the cause of this great difference in the protein absorption from first quality and the ordinary jail wheat, and have shown that it is practically a question of a pure *versus* a contaminated sample. It will be evident that, if it is impossible

to get a better quality of wheat than the average of those we worked with, it is hopeless to make any attempt to raise the percentage level of protein absorption, and therefore useless to aim at a lessening of the large residue of nitrogenous matter left over from the present dietaries. The following consideration will make this clear: wheat being the cereal exhibiting the highest degree of protein absorption, it must form a large part of the diet: if wheat only shows 67·1 per cent. of its protein absorbed, then the protein absorption from the whole diet can never be much greater than 67·1 per cent., therefore, unless the percentage absorption of the protein of wheat can be raised, no variation in the amount of wheat in the diet can ever lessen the percentage of waste by the bowel.

Fortunately for the prisoners it is possible to obtain a better class of wheat than is at present accepted for consumption; so that, we may hope to be able to decrease the large nitrogenous residue from the dietaries now in force to smaller proportions.[1]

It is well-known that there is often great admixture of other cereals with wheat when grown, but if first class wheat were demanded for jail purposes very good samples could be obtained. The present system of accepting an inferior quality of wheat for the feeding of prisoners, even though cleaned afterwards in the jails, allows too much of an opportunity for the contractor to supply material that is exceedingly dirty and mixed to an immense extent with cheaper and inferior cereals and other grains. Some of the samples we have analysed, taken from the jail stock, were very poor in quality and greatly contaminated with foreign materials.

In order, therefore, to raise the percentage of protein absorption of the jail dietaries and lessen the intestinal nitrogenous residue, the first step must be to insist on wheat of the best quality being supplied to the jails for the feeding of the prisoners. We shall show later that this will be more economical in the end than the present system.

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[1] In this connection we would draw attention to the very valuable report on Indian wheat by McDougall Brothers. This firm working with four representative Indian wheats, *viz.*,

Indian, fine soft white,
,, superior soft red,
,, average hard white,
,, ,, ,, red,

pronounce them to be exceedingly useful wheats, in fact hardly equalled for what is deficient and wanting in the English markets by any other wheats. Their great dryness and soundness render them invaluable for admixture with English wheats. Added to their dryness, their thinness of skins and consequent greatness of the yield of flour must always place them in the front rank as a "miller's" wheat. "The Indian wheats now specially under review were delivered to us in excellent condition with freedom from dirt, barley, gram, and other impurities, also with a freedom from weevils, rarely equalled by Indian wheats."

The yield of flour and bread from Indian wheats is unprecedented, ranging from 77·4 to 80·5 per cent., against English wheat 65·2 per cent. and American spring wheat 72·2 per cent.

With regard to the other cereals, juar, barley, bajra, which we investigated, the protein absorption from them is so poor that they are quite unsuitable to be used alone as the chief cereal of dietaries, if the present standard of protein metabolism shown by the prisoners is to be maintained. These three alone are ever given in the jails of the United Provinces; the other cereals, makka, marua and rice, laid down in the Jail Code, never seem to be used at all. Diets such as B, F, G, and probably D as sanctioned for the jails of the United Provinces, in which the principal cereal is bajra, juar, barley and marua, respectively, exhibit so poor an absolute and relative protein absorption that they cannot be accepted as satisfactory diets.

Thus:—

DIET B. SERIAL NO. 12.

Bajra	12 chittacks.	Intake of nitrogen 15·9798 grms.
Urid dal	2 „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

shows 9·5291 grms. of nitrogen absorption, or 59·6 per cent. of the nitrogen value of the diet.

DIET F. SERIAL NO. 11.

Juar	11 chittacks.	Intake of nitrogen 16·2748 grms.
Urid dal	3 „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

shows 8·9992 grms. of nitrogen absorption, or 55·3 per cent. of the nitrogen value of the diet.

DIET G. SERIAL NOS. 9 AND 10.

Barley	11 chittacks.	Intake of nitrogen 14·3793 grms.
Wheat	3 „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

shows 9·2264 grms. of nitrogen absorption, or 64·1 per cent. of the nitrogen value of the diet.

These results should be contrasted with those obtained for—

DIET E. SERIAL NOS. 1—7.

Wheat	11½ chittacks.	Intake of nitrogen 17·09026 grms.
Gram	2½ „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

which shows 11·64996 grms. of nitrogen absorption, or 68·16 per cent. of the nitrogen value of the diet.

Even though Diet E cannot be said to have given very good results, it is so much superior to anything presented by Diets B, F, or G, that it is not difficult to understand the action of Jail Superintendents in practically neglecting Diets B, F, and G, and making use almost entirely of Diet E, which experience has proved to be so much superior. We have no doubt but that the other neglected diets of the Jail Code, *viz.*, Diets C, D, and H, on investigation would have shown equally poor results.

It is evident, therefore, if the present standard of protein interchange is to be maintained, and if an effort is to be made to lessen the percentage of nitrogenous waste shown by the present dietaries, that juar, barley, bajra, and probably makka, marua and rice, as the principal cereals of the dietaries cannot be taken into consideration. In other words, it practically means the doing away with the dietaries as laid down in the Jail Code; Diets B, C, D, F, G, and H to disappear absolutely, and Diets A and E to be modified in a manner we shall presently make clear.

The deletion of the above diet scales from the Jail Code is not really so serious a step as it would appear to be, practical experience has long ago shown them unsatisfactory and they are never used: so that, it will only be a matter of acknowledging and endorsing officially the teachings of experience. All we have done is to corroborate by practical investigations the empirical knowledge of the Jail Superintendents and to explain on a scientific basis their findings.

Juar, barley, bajra, marua, makka and rice would therefore drop from being principals into the category of secondary food-stuffs, or could only be mixed with wheat in suitable proportions. To this, however, we shall return.

With regard to the other food-materials entering into the jail dietaries of the United Provinces, *viz.*, pulse, vegetables and oil, the only one we wish to discuss is pulse. The different pulses in use are, arhar dal, urid dal and gram dal.

Our investigations on the protein absorption exhibited by these different dals make it abundantly clear that arhar is by far superior to the other two. Thus arhar dal shows well over 80 per cent. of its protein capable of absorption, while urid at its best only gives 69·2 per cent. and gram dal 64·2 per cent. Arhar dal seems to be the favourite form of pulse with the wheat-eating population: we found this to be true for both the inhabitants of the United Provinces and Behar. The rice-eating Bengali and Ooriya, on the other hand, seem to prefer the more highly nitrogenous forms, such as mung dal and massur dal. The explanation may be a demand by the

system for more protein with a rice diet, while with diets composed principally of wheat, which already contain sufficient assimilable protein, a less highly nitrogenous form of dal seems to be more agreeable.

There can be little doubt but that the methods of cooking and preparation of the dals for consumption has a great influence on the degree of protein absorption.[1] Gram dal, for instance, is usually given as a morning meal in the form of parched gram, *i.e.*, simply fried or heated until the greater part of the contained moisture is got rid of; no steps whatever are taken to break up the grains so that the digestive juices may have a proper opportunity of carrying out their work satisfactorily. Investigations[2] on the absorption of pea and lentil flour, properly cooked, show that the protein is all taken up except about 8 to 9 per cent. If, however, the pulse is not given in a state of fine division, the loss of protein has been found to rise to 40 per cent. The following table compiled by Hutchison[3] gives the relative absorption of the protein of various foods:—

Meat	2·3	per cent. protein not absorbed.
Lentil flour	10·5	„ „ „ „ „
Dried peas	17·0	„ „ „ „ „
Beans	30·3	„ „ „ „ „
Potatoes	32·0	„ „ „ „ „
Lentils (soaked and boiled)	40·0	„ „ „ „ „

It is not, therefore, to be wondered at that gram dal, which is not cooked at all, should exhibit a bare 64·2 per cent. of its protein absorbed as given to prisoners in the United Provinces. Arhar and urid dals are usually boiled in water or ground to flour and baked into chapatties with the cereal. Arhar dal to the extent of 1 chittack enters into the composition of all jail dietaries of United Provinces, and it is very probable that the amount being small a greater percentage of its protein will be absorbed than would be the case if given in larger quantities.

Urid, on the other hand, is given in quantities of 2, $2\frac{1}{2}$ and 3 chittacks in different diets (B, C, D, and F) and that is in addition to the 1 chittack

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[1] With regard to the absorption of the protein of the pulses Church writes—"Another point connected with the nitrogen of pulse must be here noted. Some of this nitrogen exists in the form of nitrogen compounds which are not albuminoid—which are not flesh-formers, in fact, and which, for all we know, may be entirely without nutritive value. These bodies are simpler in constitution than the albuminoids, and are often of the nature of alkaloids—lupinine, a bitter basic substance from lupines, is one of these, asparagine is another. But the quantity of nitrogen existing in the pulse in the form of non-albuminoid compounds of all kinds is small, not exceeding 3 to 5 per cent. of the total albuminoids in the common kinds of ripe pulse; in the seeds, stems, and pods of the unripe plants it is very much larger." [Food-Grains of India.]

[2] Strumpell, Deut. Archiv klin. med., 1876.

[3] Hutchison: Food and the Principles of Dietetics.

of arhar dal already present in those dietaries ; so that, those diets contain 3, 3½ and 4 chittacks of total pulses, quantities that are far too great to permit of a high degree of protein absorption. We found in our work on Bengal Jail Dietaries that it was useless to increase the pulses beyond 2½ chittacks or about 5 ounces, and the evidence afforded by the work in the United Provinces would tend to corroborate that finding.

The large quantities of the pulses in the present jail dietaries of the United Provinces are due to the mistaken opinion that the nutritive value of the diets would be increased by augmenting the protein content, and the pulses providing an easy means of doing this, without unnecessarily increasing the carbonaceous material, the result has been to give dal in quantities in excess of the amount from which the maximal absorption will be obtained, and far in excess of the average amount consumed by the inhabitants of the Province in their own homes. Except in Diets A, G, and H pulses to the extent of at least 3 chittacks will be found ; and, in the majority of those diets, up to 50 per cent. of the total protein offered will be seen to be derived from dals. We have condemned Diets B, C, D, and F for other reasons, but they might also be severely criticised for the excessive amount of pulse they contain.

Diet E has been shown to be much superior to any of the other diets sanctioned for prisoners in the United Provinces. We found that, on an average over the different jails where observations were made, this diet permitted 68·16 per cent. of its protein to be absorbed, or 11·64996 grms. of nitrogen per man daily. On examining the composition of this diet it will be seen to contain 2½ chittacks of gram dal and 1 chittack of arhar, in all 3½ chittacks or over seven ounces of pulses. So that, even in this diet, the best one of the eight laid down, the quantity of pulses is at least one chittack or two ounces above the amount from which the best results may be expected. We fail to see any reason for the addition of over seven ounces of pulse to a diet largely consisting of wheat. Wheat, as we have seen, contains practically the proper relationship between its nitrogen and carbon, so that there can be no necessity for the addition of a large quantity of a highly nitrogenous material, if the quantity of wheat in the diet is already sufficient. Of course it has been added to bring the total protein value of the diet, on chemical analysis, up to what was considered the proper standard for labouring prisoners. The result is that 2½ chittacks of parched gram is given daily from which only 64·2 per cent. of the protein is absorbed, thus decreasing very considerably the percentage of protein absorption from the diet. If the gram dal were cut out of this diet altogether and an extra chittack of arhar dal substituted, we should obtain an absorption of protein quite up to the desired level and have a diet from which the percentage of nitrogenous waste was considerably lower.

We may, therefore, conclude this consideration of the pulses of these diet scales, by stating that they are present in quantities much in excess of what is required, and in far greater abundance than the people of the Province can afford, or wish to have. Two and a half chittacks or five ounces is the maximum amount of pulse that should enter into any diet, and, if gram is to be given it should be properly cooked, not made use of as parched gram, and it should never be the only pulse in the composition of the diet. The superiority of arhar dal and the fact that it is the favourite form of pulse with natives of the United Provinces should ensure that this pulse will be used in all diets to as great an extent as possible. Urid dal being more suitable than other forms in the preparation of bajra and juar for consumption, this dal should be used in diets into the composition of which those cereals enter. One chittack of urid dal will be found amply sufficient in the cooking of the quantities of juar or bajra recommended in new dietaries.

SUMMARY OF THE DIFFERENT POINTS DISCUSSED WITH CONCLUSIONS ARRIVED AT REGARDING THE FOOD-STUFFS AND DIETARIES OF THE JAILS OF THE UNITED PROVINCES.

1. Taking the dietaries as a whole we found that they afforded a metabolism of 11·286 grms. of nitrogen per man daily on the average throughout the year. For reasons advanced we do not consider this amount excessive, while we do consider it quite sufficient. The physiological weaknesses of these dietaries in general were : —

(*a*) The large nitrogenous residue left over in the intestinal tract affording great opportunity for the growth of putrefactive micro-organisms.

(*b*) The excessive caloric value of the dietaries, providing up to 50 per cent. more potential energy per kilo of body-weight than the standard diets, framed for Europeans living in cold climates, provide.

The correction of these faults will be to the advantage of both the prisoners and the State.

A non-physiological weakness of the dietaries is that they are much superior to those available for the great majority of the population and therefore tend to put a premium on crime.

2. With regard to the individual food-stuffs, wheat shows a marked superiority over other cereals : even wheat of the quality used in the jails gives a higher co-efficient of protein absorption than juar, bajra or barley. Good

wheat we found to be an ideal food and one that exhibited the lowest percentage of protein waste of all the cereals. Poor quality of wheat, while superior to juar, bajra or barley, gives too much nitrogenous residue for the bowel to deal with to be satisfactory.

In order, therefore, to prevent excessive protein waste by the bowel good first class wheat should replace the quality at present accepted for jail consumption.

If the best quality of wheat were used, a smaller quantity would give as good results, as regards the level of nitrogenous metabolism, as the present amount shows. Therefore, being able to decrease the quantity of wheat in the dietaries, by giving a better quality, we should tend to correct both the physiological weaknesses of the dietaries above mentioned.

That it is possible to obtain better quality of wheat than accepted for jail consumption, we have shown by working with a first class wheat in Benares Jail.[1]

3. Regarding the other cereals, bajra, juar and barley, the absorption of protein from them is so poor that they are unsuitable to form alone the principal cereal of dietaries.[2] This condemnation involves all the dietaries except Diets A and E of the Jail Code. However, as the condemned diets have been discontinued for years, our work had simply afforded an explanation of their neglect. The fact that Diet E is used practically entirely in the feeding of prisoners throughout the province can be explained by the superiority of its nutritive value.

4. Of the different forms of pulse used in the dietaries arhar dal is decidedly superior, showing 80 to 84 per cent. of its protein capable of absorption, while gram dal only has 64·2 per cent. absorbed. Gram dal probably suffers considerably from the method of cooking in use, *viz.*, parching. Urid dal shows 69 per cent. of protein absorption, but probably would give a higher figure if made use of in diets in which wheat, instead of juar or bajra, formed the principal cereal, and in which it was made use of in smaller quantities.

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[1] In connection with the quality of Indian wheat Church states—"Besides the general dryness of the grain of Indian wheat, which, as imported in bulk into this country and analysed promptly, contains at least 2 per cent. less moisture than average English wheat, the albuminoids are decidedly higher. I have never yet met with an Indian wheat containing less than 10 per cent. of albuminoids ; but a large number of samples of first-rate of English. Canadian and Australian samples give numbers between 8 and 9." [Food-Grains of India.]

[2] It is very probable the explanation of the low percentages of nitrogen absorption shown by these food materials, and also rice in Bengal Jail Dietaries, is that the protein in these cereals does not exist in a form capable of absorption by the human alimentary system. If this explanation should turn out to be the true one, it would account for the great loss of protein in the fæces with dietaries into whose composition any of these cereals enter at all largely. The superiority of the protein absorption of wheat would indicate that more of its nitrogen is present in an assimilable form than is the case with bajra, juar, barley or rice.

We find that the quantities of pulse entering into the composition of the dietaries, even Diet E, are too high, and suggest that no diet should contain more than 2½ chittacks of pulses, of which as much as possible should be in the form of arhar dal.

This concludes all we have got to say with regard to the suitability of the dietaries at present in force for prisoners in the United Provinces. We shall now attempt to frame diet scales based, not on the gross chemical composition of the different food-materials as has been done in the case of the present dietaries, but on the real nutritive value of the food-stuffs as found by practical investigation.

CHAPTER VII.

The Revision of the Jail Dietaries of the United Provinces and suggestions for New Scales.

For the sake of ease of reference and clearness we reproduce here the table giving the jail dietaries in force in the United Provinces.

Combination Diet.	Principal.		Adjuvant.		Dal, Quantity.	Total, Quantity.
	Grain.	Quantity.	Grain.	Quantity.		
		Chittacks.		Chittacks.	Chittacks.	Chittacks.
A . . .	Wheat .	11	Barley .	3	1	15
B . . .	Bajra .	12	Pulse .	2	1	15
C . . .	Makka .	12	Do. .	2	1	15
D . . .	Marua .	11½	Do. .	2½	1	15
E . . .	Wheat .	11½	Gram .	2½	1	15
F . . .	Juar .	11	Pulse .	3	1	15
G . . .	Barley .	11	Wheat .	3	1	15
H . . .	Rice .	10¼	Do. .	3¾	1	15

It may be accepted at once that the most important thing we have to deal with in framing dietaries, composed of vegetable foods, is the protein element. Any vegetable diet that permits of an absorption of protein up to the standard attained on the average by the above diets will provide abundant carbonaceous material, and a potential energy sufficient for the needs of the body.

The problem before us is, therefore, to devise combinations of the food-materials of the United Provinces that will permit of a degree of protein metabolism equal to the average level presented by the above dietaries and combinations that, at the same time, will attain a higher percentage of protein absorption, so that the waste of nitrogenous material from the bowel may be decreased to as great an extent as possible.

The level of protein metabolism will depend on the extent to which the protein of the several food-stuffs entering into the composition of the diets is absorbed, and on the quantities of protein offered. We have determined the

percentage of protein absorption shown by the different food-materials in use to be :—

1st class wheat . . .	80·6 per cent. protein absorption.
Jail „	67·1 „ „ „ „
Gram dal	64·2 „ „ „ „
Arhar „ . . .	81 to 84 „ „ „ „
Arhar dal *plus* vegetables . .	80·5 „ „ „ „
Urid dal	69·2 „ „ „ „
Juar	53·0 „ „ „ „
Barley	57·6 „ „ „ „
Bajra	49·4 „ „ „ „

In working out our dietaries the protein absorption must be based on these figures and not, as hitherto, on the gross chemical composition of the food-stuffs. The fallacy of the method of framing a series of diets composed of different food-materials, such as in above table, whose gross chemical composition is nearly identical and then expecting that each diet will permit of the same degree of protein metabolism, is made very apparent when we see how greatly one food-material differs from another in the percentage of protein absorption possible from it. When the above table of diets was framed, each representing practically the same quantity of nitrogen (we have shown this not to be the case), it was supposed that the diets were equally good and that similar quantities of protein would be absorbed from each ; instead of this being so, we find that the level of protein metabolism varies for the different diets between 8·99 grms. and 11·65 grms. of nitrogen per man daily, or over 23 per cent.

Looking, therefore, on the food-materials from the standpoint of the percentage of protein absorption possible from them, we came to the conclusion that juar, barley and bajra could not be retained amongst the principals in the formation of new dietaries ; and, therefore, that Diets B, F, and G were useless. Marua we have not worked with, but it is a millet something like juar and would probably show a similar co-efficient of protein absorption. It is never used, so far as we could learn, in the jails of the United Provinces. In case of it ever being called into requisition we shall give its co-efficient of protein absorption the same value as juar.

Rice is too expensive ever to be called on and, if ever used in future, the quantity given in Diet H is too great. We saw in Bengal diets of the type of Diet H that the protein metabolism possible would be well below the average we wish to maintain, *viz.*, 11·286 grms. of nitrogen per man daily. Diet H may, therefore, go completely.

Diet C, in which the principal is makka or maize, we have not investigated. It is never used, so far as we could gather, in the dietaries of the prisoners. Maize we found in Bengal was a very good food-material, although not very palatable as prepared in Bengal Jails. It is not suitable alone for baking into bread or chapatti, but is very good when mixed with wheat or prepared as porridge. We do not think it suitable as a principal, as in Diet C, but see no reason why maize should not be given as a substitute for part of the wheat in dietaries. Why it should never be given in the jails of the United Provinces is difficult to understand, as, next to wheat, maize in the best cereal on the list. It is used during its season fairly largely by the inhabitants of the province, and the average crop being up to one million tons, there cannot be any great scarcity of this food to enhance its price. We are strongly of the opinion that maize has been neglected unjustly, and that, if given as we suggest, mixed with wheat, it would be found quite satisfactory. Probably, it has only been tried as in Diet C, which, being found unsatisfactory, no further test was made. We have no hesitation in saying from the results obtained in the Behar Jails that maize, given along with wheat, would show a protein absorption up to 70 per cent.

Diet E is used practically to the exclusion of all others in the jails of the United Provinces. We have seen that it is much superior to any on the list, affording a metabolism of 11·64996 grms. of nitrogen per man daily. We consider this diet faulty in that it contains too much pulse, $3\frac{1}{2}$ chittacks per man daily, and in that gram is usually given in the form of parched gram, with the result that the protein absorption is low, 64·2 per cent. This diet, however, could easily be transformed into a satisfactory one.

There remains Diet A, which appears to us to be of the proper type, *viz.*, a combination of two cereals, one to be wheat, with a pulse. The quantities of the different food-stuffs could probably be better arranged than as given in the Jail Code. In our observations on the absorption of the protein of this diet, serial No. 8, the wheat in use was of very poor quality, so that it could hardly be looked on as a fair test. With good quality of wheat a diet of this type would show a level of nitrogenous metabolism quite up to the standard we require, and a percentage of protein absorption much higher than that obtainable with the present dietaries.

We may conclude, therefore, that Diets A and E as types are worth retaining, although requiring modification. The remaining six dietaries are unsatisfactory and are not worth any further considerations.

There is one more point, the importance of which we cannot emphasise too strongly, to be called to mind before proceeding to the working out of diet scales. That is the quality of the wheat to be used. It is absolutely essential,

if we are to know what the effect of a diet is to be, that when a certain quantity of wheat is ordered in a diet, that amount of wheat will be given, and not a mixture of wheat, barley, gram and other grains that are not food-materials at all. For instance, take the results shown by Diet A mentioned above. We found that :—

Diet A.

Wheat	11 chittacks	10·0826 grms.	nitrogen
Barley	3 „	2·3412 „	„
Arhar	1 chittack	2·0782 „	„
Vegetables	3 chittacks	0·5000 „	„

with a nitrogen intake of 15·0020 grms. showed 9·708 grms. nitrogen absorbed, or 64·7 per cent. of the nitrogen of the diet.

Supposing this had been first class wheat instead of being wheat very inferior in quality, the relative and absolute protein absorption shown by the diet would have been very different. Eleven chittacks of first class wheat would offer 11·8733 grms. nitrogen.

Therefore, making use of our co-efficients of protein absorption we should have $11{\cdot}8733 \times 80{\cdot}6 + 2{\cdot}3412 \times 57{\cdot}6 + 2{\cdot}5782 \times 80{\cdot}5$, that is, 12·9937 grms. nitrogen absorption or 77·4 per cent. of the nitrogen of the diet. An absolute increase of over 3 grms. of nitrogen per man daily and a relative increase of 12·7 per cent. in the protein absorption from the diet.

This example not only makes clear the importance of the quality of wheat in raising the level of protein metabolism, but also shows that the quantity of wheat, when first quality is made use of, can be considerably diminished and still maintain a level of protein metabolism up to the standard of the present dietaries.

Diet A with first quality wheat gives a nitrogenous metabolism of 12·9937 grms., whereas we only require a metabolism of 11·286 grms.; so that, the wheat could be considerably reduced and still offer a diet of a nutritive value equal to the present dietaries. Further, as we have already pointed out, a good quality of wheat must be given if the percentage of nitrogenous waste excreted by the bowel is to be lessened. The large residue of nitrogenous material, capable of undergoing putrefactive changes and causing intestinal irritation, is the great fault of the present types of dietaries and calls for correction.

We shall now proceed to work out dietaries composed of the food-materials

easily obtainable in the United Provinces. In doing so we shall observe the following conditions:—

(1) The dietaries suggested to afford a protein metabolism at least equal to that found as the average level of the present dietaries.

(2) The dietaries suggested to decrease as much as possible the excessive nitrogenous waste of the present dietaries.

(3) The dietaries suggested to lessen, if possible, the excessive carbohydrate element and caloric value of the present dietaries.

(4) The dietaries suggested to fulfil these conditions without an increase in the amount of pulse beyond $2\frac{1}{2}$ chittacks.

In order to carry out these several conditions it will be evident that wheat must enter largely into the composition of all dietaries suggested.

The simplest way of solving the problem will be to accept as our unit of weight the chittack, equal to 2·05 ozs. avoirdupois; to work out the average value of one chittack of the different food-materials in nitrogen and carbohydrates, and then, by making use of the co-efficients of nitrogen absorption, to determine the quantity of nitrogen that will be absorbed from one chittack of each food-material.

Having found the amount of nitrogen that will undergo metabolism from one chittack of each food-stuff, we shall be in a position to work out the combinations of the different food-materials that will fulfil the above conditions; being guided all the time by the results actually obtained from practical observations on the dietaries suggested or on very similar dietaries. In this way we shall obtain a series of diets whose several combinations are based on the real nutritive value of the food-materials and not on their apparent value or gross chemical composition, and a series of diets from which the level of protein absorption will be comparatively high and practically identical for each diet of the series.

Table of food-stuffs showing the amount of Nitrogen and Carbohydrate per chittack with absorption of Nitrogen per chittack of food-material.

Food-stuff.	Carbohydrate per chittack.	Nitrogen per chittack.	Absorption of nitrogen per chittack.
	Grms.	Grms.	Grms.
1st class wheat	42·45	1·1144	0·89820
Jail wheat	42·13	0·9460	0·63476
Gram dal	29·38	1·7060	1·09525
Arhar „	31·31	2·02505	1·70104

Food-stuff.	Carbohydrate per chittack.	Nitrogen per chittack.	Absorption of nitrogen per chittack.
	Grms.	Grms.	Grms.
Urid dal	32·10	2·07715	1·43738
Barley	44·24	0·82974	0·47793
Juar	39·10	0·71347	0·37814
Bajra	42·67	0·8114	0·40070
Makka (1)	38·48	0·88835	0·59963
Vegetables	8·50	0·16650	0·12704
Marua (2)	42·52	0·67905	0·35989

(1) These figures are based on analyses of makka or maize carried out from material supplied by the Bengal Jails. The absorption of the protein of makka is taken at 67·5 per cent.

(2) These figures are based on an analysis of marua by Church.

Albuminoids	7·30 per cent.
Starch	73·20 „ „
Fat	1·50 „ „

Marua is said to be much used by poorer classes in Western India usually in the form of porridge. It is considered to be particularly wholesome and digestible, and a thin gruel made from it is much used, mixed with cow's milk, for weaning children and as a diet for invalids.

With first quality of wheat in use we believe the proper type of diet for inhabitants of the United Provinces to be a combination of wheat and another cereal with a pulse: the wheat to predominate. However, there are seasons of the year when most of the cereals except wheat are scare, so that it will be necessary to have a diet of the type of Diet E, *viz.*, the combination of wheat with pulses, capable of being used when the other food-materials fail. With the option of several other good types of diets, there should be no necessity to keep prisoners on the diet we suggest of the type of Diet E for long periods, as is the case at present.

Marua is an early rains crop and is available by August. Bajra and juar are available during the winter months. Barley is available most of the year and makka for several months. There is therefore a fairly wide choice of food-materials to select from over the greater part of the year.

We shall now consider the framing of a diet, similar in type to Diet E of the Jail Code, for use during periods when other cereals, except wheat, fail or are so scare as to be comparatively expensive.

Diet I.—Wheat and Pulse Combination.

Diet E of the Jail Code we found to be faulty in that it presents too much pulse entering into its composition, and that the pulse with the lowest co-efficient of protein absorption—gram dal—forms $2\frac{1}{2}$ chittacks of a total of $3\frac{1}{2}$ chittacks. Also that the gram is badly prepared for consumption.

We found that Diet E on the average offered 17·09026 grms. nitrogen of which 11·64996 grms. were absorbed, or 68·16 per cent. of the nitrogen of the diet.

In order to correct the above-mentioned faults and raise the percentage of protein absorption, we would suggest that :—

First quality of wheat alone be given, the quantity being reduced.

Gram dal be either left out entirely or the quantity largely reduced.

Arhar dal, which shows a high co-efficient of protein absorption, be increased.

We therefore propose the following :—

Diet I. (*a*)	1st class Wheat	10½ chittacks	= 11·7002 grms.	nitrogen	Total value 16·2503 grms. nitrogen.
	Arhar	2 „	= 4·0501 „	„	
or	Vegetables	3 „	= 0·5000 „	„	
Diet I. (*b*)	1st class Wheat	10½ chittacks	= 11·7002 grms.	nitrogen	Total value 16·78425 grms. nitrogen.
	Gram	1½ „	= 2·5590 „	„	
	Arhar	1 chittack	= 2·02505 „	„	
	Vegetables	3 chittacks	= 0·5000 „	„	

Diet I. (*a*). This diet offers an intake of 16·2502 grms. nitrogen of which 13·2143 grms. will be absorbed, or 81·3 per cent. of the nitrogen of the diet.

Reference to the observations recorded under serial Nos. 21 and 22 will show that we have investigated this type of dietary with first class wheat and found that it gives results practically the same as worked out above.

This diet appears to us to be the best obtainable with the food-materials at our command. It fulfils all the conditions we laid down, the most important, to decrease as much as possible the excessive nitrogenous waste of the present dietaries, being well met; this diet showing under 19 per cent. of nitrogenous waste, while the loss with the present dietaries, on the average, is 32·6 per cent. Further, this suggested diet raises the absolute level of protein metabolism also, allowing of nitrogenous interchanges up to 13·2143 grms. per man daily compared with that of 11·286 grms. from the dietaries now in force. Another point in favour of this diet is that the excessive carbohydrate element of the present dietaries is largely reduced, *viz.*, from an average of 625 grms. to 532·83 grms. per man daily. The caloric value is also closer to what would be

considered the proper standard, *viz.*, 2,810 calories in place of 3,260 calories furnished by the present dietaries. This heat value is still very high permitting of 52 calories per kilo of body-weight in place of 60 calories offered in present dietaries: both these figures being greater than that considered sufficient for Europeans.

We might draw up the different points of contrast to show the distinctions clearly :—

	Average of present Dietaries.	Suggested Diet I (*a*).
Nitrogen offered . .	16·7292 grms.	16·2503 grms.
„ absorbed .	11·2860 „	13·2143 „
Percentage absorbed .	67·4 per cent.	81·3 per cent.
„ wasted .	32·6 „	18·7 „
Carbohydrates offered .	625·0 grms.	532·83 grms.
Heat value . .	3,260 calories.	2,810 calories.
Calories per kilo of body-weight.	60 „	52 „

There can be little doubt, therefore, of the superiority of Diet I (*a*).

Diet I (*b*). This diet offers an intake of 16·78425 grms. nitrogen of which 13·15613 grms. will be absorbed, or 78·4 per cent. of the nitrogen of the diet.

Contrasted as before :—

	Average of present Dietaries.	Suggested Diet I (*b*).
Nitrogen offered . .	16·7292 grms.	16·7842 grms.
„ absorbed .	11·2860 „	13·15613 „
Percentage absorbed .	67·4 per cent.	78·4 per cent.
„ wasted .	32·6 „	21·6 „
Carbohydrate offered .	625·0 grms.	546·6 grms.
Heat value . . .	3,260 calories.	2,914 calories.
Calories per kilo of body-weight.	60 „	54 „

Diet I (*b*) is, therefore, much superior to the dietaries now in force, although not so good a combination as Diet I (*a*).

It may well be asked why Diet I (*b*) has been introduced at all, seeing that Diet I (*a*) is quite satisfactory and is a better combination. Our reason for its introduction is that gram is largely used by the inhabitants of the province and is a favourite food-stuff with Jail Superintendents for use as an early morning meal, when it is given as parched gram. Although we are not much impressed with the value of parched gram as a food-material, still we think it better to frame a diet containing gram, so that it can be used if desired. Given in the combinations we recommend it is a very good diet, being much superior to any of dietaries at present in force.

It will be evident that Diets I (*a*) and I (*b*) are in reality substitutes for Diet E of the Jail Code, they should, therefore, be contrasted with Diet E and the distinctions noted. Thus :—

	Diet E of present scales.	Diet I (*a*).	Diet I (*b*).
Nitrogen offered .	17·09206 grms.	16·2503 grms.	16·7842 grms.
„ absorbed .	11·64996 „	13·2143 „	13·15613 „
Percentage absorbed	68·16 per cent.	81·3 per cent.	78·4 per cent.
„ wasted .	31·84 „	18·7 „	21·6 „
Carbohydrate offered	614·68 grms.	532·83 grms.	546·6 grms.
Heat value . .	3,242 calories	2,810 calories	2,914 calories.
Calories per kilo of body-weight.	60 „	52 „	54 „

So that, under every heading Diets I (*a*) and I (*b*) are superior to the diet which is undoubtedly the best of those in present use.

There is just one other point we wish to mention with regard to the suggested Diets I (*a*) and I (*b*). It will be noticed that the quantities of nitrogen undergoing metabolism from them are considerably higher than that attained on the average from the present dietaries, by almost 2 grms. of nitrogen per man daily. It may be wondered at, why we do not arrange the several combinations in such quantities that a closer approach to the present standard is obtained, seeing that the nitrogenous interchange possible from the dietaries now in force is amply sufficient for the requirements of the body. Our reason is two-fold. First, to have combinations of first class wheat with pulse in such quantities that a level of 11·268 grms. of nitrogenous metabolism should take place, it would mean a considerable reduction in the total weight and volume of the dietaries below that at which Diets I (*a*) and I (*b*) stand. We do not consider it advisable to lower the quantity of a vegetable diet below two pounds of uncooked material daily. The diets we suggest are not much over this standard. Secondly, it is intended that these diets should be used during the periods of the year when other cereals are scare, *i.e.*, before the new crops are ready. This in reality will mean that the wheat and pulses are old and likely to have been damaged to some extent during storage, as by weevils. It would, therefore, be necessary to have something in reserve in dietaries used during those periods to make up for any falling off in the nutritive value of the food-stuffs. This we have provided for in Diets I (*a*) and I (*b*) to the extent of 2 grms. of nitrogen per man daily, or almost 15 per cent. of the total nitrogenous metabolism.

We may conclude, therefore, that Diets I (*a*) and I (*b*) are superior in every detail to any of those at present in use, and that they are particularly suitable for the late hot weather and rains, during which food materials are apt to deteriorate, as they provide a considerable margin of reserve above ordinary requirements.

We shall now consider the framing of dietaries similar in type to Diet A of the Jail Code, *i.e.*, the combination of wheat and another cereal with pulse. As these diets would be used during the period of the year when the different food-stuffs are fresh—roughly from September to April, although barley might have a longer period—there will be no necessity to provide for a much higher level of nitrogenous metabolism than that shown on the average by the present dietaries, *viz.*, 11·286 grms. nitrogen per man daily.

Diet II.—Wheat and another Cereal with Pulse.

In this type of dietary we have open to us combinations of wheat with—

(*a*) Barley.
(*b*) Makka.
(*c*) Juar.
(*d*) Bajra.
(*e*) Marua.

We have therefore to work out the particular combinations of these food materials with pulse that will satisfy the above conditions and provide a sufficiency of the different proximate principles.

Diet II (*a*).—Wheat, Barley and Pulse Combination.

Wheat	8 chittacks	8·91520 grms. nitrogen.	} Total value 15·95452 grms.	
Barley	3 „	2·48922 „ „		
Arhar	2 „	4·05010 „ „		
Vegetables	3 „	0·50000 „ „		

The absorption from this diet will be 12·40259 grms. nitrogen, or 77·74 per cent. of the nitrogen of the diet.

This amount provides slightly over 1 grm. of nitrogen more undergoing metabolism than the average amount of the present dietaries, and thus affords a good measure of reserve.

Contrasted with the average of the present dietaries we get:—

	Average of present dietaries.	Suggested Diet II (*a*).
Nitrogen offered	16·7292 grms.	15·95452 grms.
„ absorbed	11·2860 „	12·40259 „
Percentage absorbed	67·4 per cent.	77·74 per cent.
„ wasted	32·6 „ „	22·26 „ „
Carbohydrate offered	625·0 grms.	560·44 grms.
Heat value	3,260 calories	2,920 calories.
Calories per kilo of body-weight.	60 „	54 „

Diet II (*a*) is therefore superior under every heading to the average of the present dietaries.

Diet II (*b*).—Wheat, Makka and Pulse Combination.

Wheat	7 chittacks	7·80080 grms.	nitrogen	Total value 15·9564 grms. nitrogen.
Makka	4 „	3·55340 „	„	
Urid dal	1 chittack	2·07715 „	„	
Arhar	1 „	2·02505 „	„	
Vegetables	3 chittacks	0·50000 „	„	

The absorption from this diet will be 12·20546 grms. nitrogen, or 76·50 per cent. of the nitrogen of the diet.

This amount provides slightly under 1 grm. of nitrogen more undergoing metabolism than the average of the present dietaries, and thus affords a good measure of reserve. Besides this the protein absorption from makka is calculated at 67·5 per cent. which is probably rather below the mark.

Urid has been introduced in the diet to assist in the cooking of the makka, but we do not believe this is really necessary; maize or Indian meal blends quite well with wheat flour and forms a most palatable bread. It is open therefore to Superintendents to substitute one chittack of arhar dal for urid; if this be done the absorption from the diet will be increased to 12·4691 grms. of nitrogen, or 78·1 per cent. of the nitrogen of the diet, providing over 1 grm. of nitrogen more than the present dietaries.

We shall, however, leave the diet as arranged, giving Superintendents the option of modifying it in the manner stated.

Contrasted with the average of the present dietaries we get :—

	Average of present dietaries.	Suggested Diet II (*b*).
Nitrogen offered	16·7292 grms.	15·9564 grms.
„ absorbed	11·2860 „	12·20546 „
Percentage absorbed	67·4 per cent.	76·5 per cent.
„ wasted	32·6 „	23·5 „ „
Carbohydrate offered	625·0 grms.	540·0 grms.
Heat value	3,260 calories	2,810 calories.
Calories per kilo of body-weight.	60 „	52 „

Diet II (*b*) therefore is superior under every heading to the average of the present dietaries.

Diet II (*c*).—Wheat, Juar and Pulse Combination.

Wheat	8 chittacks	8·9152 grms.	nitrogen.	Total value 16·3191 grms. nitrogen.
Juar	4 „	2·8538 „	„	
Arhar	2 „	4·0501 „	„	
Vegetables	3 „	0·5000 „	„	

The absorption from this diet will be 12·48136 grms. nitrogen, or 76·5 per cent. of the nitrogen of the diet.

Reference to serial No. 36, where a diet of this type was investigated, will show even a better percentage of protein absorption than we calculate for this diet, *viz.*, 77·6 per cent.

The protein absorption from this diet provides just 1·2 grms. of the nitrogen per man daily more than is derived from the average of the present dietaries, thus affording a good measure of reserve.

Some Superintendents prefer to give urid dal when juar forms part of the diet. There is no necessity for doing so when wheat and juar are given in combination. We have cooked this type of dietary hundreds of times and never found any difficulty. However, there is nothing further against urid dal entering into its composition than that it means a certain degree of lowering of the relative and absolute protein absorption; so that, if Superintendents desire, they could replace 1 chittack of arhar by a like quantity of urid dal. The effect of this would be to reduce the protein absorption to 12·2177 grms. nitrogen, or 74·6 per cent. of the nitrogen of the diet.

We shall, however, leave the diet as arranged, giving Superintendents the option of substituting 1 chittack of urid dal for a similar quantity of arhar, if they so desire.

Contrasted with the average of the present dietaries we get :—

	Average of present dietaries.	Suggested Diet II (*c*).
Nitrogen offered .	16·7292 grms.	16·3191 grms.
„ absorbed .	11·2860 „	12·48136 „
Percentage absorbed .	67·4 per cent.	76·5 per cent.
„ wasted .	32·6 „	23·5 „
Carbohydrate offered .	625·0 grms.	584·1 grms.
Heat value . .	3,260 calories	3,056 calories.
Calories per kilo of body-weight. .	60 „	56·6 „

Diet II (*c*) therefore is superior under every heading to the average of the present dietaries. The carbohydrates and caloric value are too high, but it is impossible to get these lower without upsetting the balance of the diet by increasing the quantity of the pulses at the expense of a cereal; thus repeating the mistake of the present dietaries.

Diet II $(d)_1$—Wheat, Bajra and Pulse Combination.

Wheat .	8 chittacks .	8·91520 grms.	nitrogen.	Total value 16·70986 grms. nitrogen.
Bajra . .	4 „ .	3·24456 „	„	
Arhar . .	2 „ .	4·05010 „	„	
Vegetables .	3 „ .	0·50000 „	„	

The absorption from this diet will be 12·5716 grms. nitrogen, or 75·2 per cent. of the nitrogen of the diet. See also serial No. 45.

This amount provides almost 1·3 grms. of nitrogen per man daily more than that of the average of the present dietaries.

Urid dal is sometimes given when bajra forms part of a diet. Our experiments have not shown any necessity for this, when bajra and wheat are given combined as in above. However, it may be left to the option of Superintendents to give 1 chittack each of arhar and urid dals, instead of 2 chittacks of arhar. The effect of doing so would be to lower the relative and absolute absorption of protein to 12·30794 grms. nitrogen, or 73·4 per cent. of the nitrogen of the diet.

We shall, however, leave the diet as arranged, giving Superintendents the option of modifying it in this manner if considered advisable.

The diet can stand the substitution of 1 chittack of urid for the same amount of arhar dal, so far as the level of protein metabolism is concerned; but it brings the amount of protein waste above 26 per cent., which we consider too high, we therefore do not recommend the change.

Contrasted with the level of the present dietaries we get :—

	Average of present dietaries.	Suggested Diet II $(d)_1$.
Nitrogen offered . .	16·7292 grms.	16·70986 grms.
„ absorbed .	11·2860 „	12·5716 „
Percentage absorbed .	67·4 per cent.	75·2 per cent.
„ wasted .	32·6 „	24·8 „
Carbohydrate offered .	625·0 grms.	598·3 grms.
Heat value . . .	3,260 calories	3,168 calories.
Calories per kilo of body-weight.	60 „	58·7 „

Diet II $(d)_1$ therefore is superior under every heading to the average of the present dietaries. The carbohydrates and caloric values are distinctly too high and require reduction. It is possible that a better combination would be—wheat 8 chittacks with bajra 3 chittacks than as above, this would give a protein metabolism of 12·1709 grms. nitrogen, or 76·5 per cent. of nitrogen of diet.

It would reduce the carbohydrates by 42·67 grms. to 555·63 grms., the heat value by 175 calories to 2,993 calories, and the calories per kilo of body-weight to 55·4 calories. Physiologically it appears to us a better diet and amply sufficient to meet the requirements of the body. The only point against it is that if urid dal were substituted for half the arhar dal, the level of protein metabolism would fall below 12 grms. of nitrogen per man daily, *viz.*, to 11·9072 grms. It is our object in framing these dietaries to arrange the

combinations in such a way that there should be a metabolism of at least 12 grms. of nitrogen per man daily.

We may accept this dietary on the condition that 2 chittacks of arhar dal shall always be given.

This diet would therefore be—

DIET II $(d)_2$.

Wheat	8 chittacks	8·91520 grms. nitrogen	Total value 15·89852 grms. nitrogen.
Bajra	3 „	2·43342 „ „	
Arhar	2 „	4·05010 „ „	
Vegetables	3 „	0·50000 „ „	

of which 12·1709 grms. nitrogen are absorbed, or 76·5 per cent. of the nitrogen of the diet.

Contrasted with the level of the present dietaries we get:—

	Average of present dietaries.	Suggested Diet II $(d)_2$.
Nitrogen offered	16·7292 grms.	15·89852 grms.
„ absorbed	11·2860 „	12·17090 „
Percentage „	67·4 per cent.	76·5 per cent.
„ wasted	32·6 „ „	23·5 „ „
Carbohydrate offered	625·0 grms.	555·63 grms.
Heat value	3,260 calories	2,993 calories.
Calories per kilo of body-weight.	60 „	55·4 „

DIET II (*e*).—WHEAT, MARUA AND PULSE COMBINATION.

Wheat	8 chittacks	8·91520 grms. nitrogen	Total value 16·2336 grms. nitrogen.
Marua	4 „	2·71620 „ „	
Urid dal	1 chittack	2·07715 „ „	
Arhar dal	1 „	2·02505 „ „	
Vegetables	3 chittacks	0·50000 „ „	

The absorption from this diet will be 12·1447 grms. nitrogen, or 74·8 per cent. of the nitrogen of the diet.

We have taken the co-efficient of the protein absorption of marua at the same figure as juar, 53 per cent. If this be about right, the above diet could be made use of in those jails where marua-eating prisoners are incarcerated.

Contrasted with the level of the present dietaries we get:—

	Average of present dietaries.	Suggested Diet II (*e*).
Nitrogen offered	16·7292 grms.	16·2336 grms.
„ absorbed	11·2860 „	12·1447 „
Percentage „	67·4 per cent.	74·8 per cent.
„ wasted	32·6 „ „	25·2 „ „
Carbohydrate offered	625·0 grms.	598·5 grms.
Heat value	3,260 calories	3,086 calories.
Calories per kilo of body-weight.	60 „	57 „

Diet II (*e*) therefore is superior under every heading to the average of the present dietaries. Its carbohydrate and caloric values are too high, but they cannot be decreased without diminishing the level of protein metabolism below 12 grms. nitrogen per man daily, unless we increase the amount of pulse at the expense of the cereals, which we are not inclined to do.

Two chittacks or over a quarter of a pound of pulse daily is quite as much as the intestinal tract can deal with satisfactorily; any large increase beyond this amount is likely to set up diarrhœa and irritation of the bowel.

This completes our efforts on the framing of dietaries for use in the jails of the United Provinces. We shall now bring them together in tabular form in a manner similar to that made use of for the dietaries at present in force in the Jail Code.

Table showing the new scales of Dietaries proposed.

Proposed Diets.	Principal.		Adjuvant.		Dal.		Vegetables. Quantity.	Total Quantity.
	Grain.	Quantity.	Grain.	Quantity.	Grain.	Quantity.		
I (*a*)	Wheat	10½ chittacks	...	...	Arhar	2 chittacks	3 chittacks	15½ chittacks.
I (*b*)	,,	10½ ,,	Gram	1½ chittacks	,,	1 chittack	3 ,,	16 ,,
II (*a*)	,,	8 ,,	Barley	3 ,,	,,	2 chittacks	3 ,,	16 ,,
II (*b*)	,,	7 ,,	Makka	4 ,,	[1] Urid Arhar	1 chittack 1 ,,	3 ,,	16 ,,
II (*c*)	,,	8 ,,	Juar	4 ,,	Arhar [2]	2 chittacks	3 ,,	17 ,,
II $(d)_1$	,,	8 ,,	Bajra	4 ,,	Arhar [2]	2 ,,	3 ,,	17 ,,
II $(d)_2$	,,	8 ,,	,,	3 ,,	Arhar	2 ,,	3 ,,	16 ,,
II (*e*)	,,	8 ,,	Marua	4 ,,	[1] Urid Arhar	1 chittack 1 ,,	3 ,,	17 ,,

We shall now draw up a table giving the several points of importance, contrasting them in the present dietaries with what obtains in the proposed scales.

[1] Superintendents to have the option of giving arhar dal 2 chittacks instead of 1 chittack each of urid and arhar dals.

[2] Superintendents to have the option of substituting 1 chittack of urid dal for 1 chittack of arhar.

Table contrasting the Points of Chief Importance in the Present Dietaries, Voit's Standard and in the Proposed Scales.

Headings of important points.	Average of present dietaries.	Diet I (*a*).	Diet I (*b*).	Diet II (*a*).	Diet II (*b*).	Diet II (*c*).	Diet II $(d)_1$.	Diet II $(d)_2$.	Diet II (*e*).	Diet Voit's Standard.
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Nitrogen offered in Diet . . .	16·7292	16·2503	16·7842	15·9545	15·9564	16·3191	16·7098	15·8985	16·2336	18·88
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Nitrogen absorbed	11·2860	13·2143	13·15613	12·4025	12·2054	12·4813	12·5716	12·1709	12·1447	16·80
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Percentage absorbed . . .	67·4	81·3	78·4	77·74	76·5	76·5	75·2	76·5	74·8	88·9
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Percentage wasted	32·6	18·7	21·6	22·26	23·5	23·5	24·8	23·5	25·2	11·1
	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.	Grms.
Carbohydrate offered	625·0	532·83	546·6	560·44	540·0	584·1	598·3	555·63	598·5	500·0
	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.
Heat value of Diet	3,260	2,810	2,914	2,920	2,810	3,056	3,163	2,993	3,086	3,000
	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.	Calories.
Calories per kilo of body-weight . .	60	52	54	54	52	56·6	58·7	55·4	57	40

Diets II (*b*) and II (*e*) may be slightly increased under the first three headings by the substitution of 1 chittack of Arhar for 1 chittack of Urid dal.
Diets II (*c*) and II $(d)_1$ may be slightly decreased under the first three headings by the substitution of 1 chittack of Urid for 1 chittack of Arhar dal.

These tables are simple and easily understood. It will be seen that we have been guided in the framing of these dietaries by the degree of protein absorption possible from them. In Diets I (*a*) and I (*b*) the level of protein metabolism has been arranged somewhat higher than in Diet II series. We have stated our reasons for this. Dict II series show a level of nitrogenous interchange of over 12 grms. nitrogen per man daily, on an average 1 grm. nitrogen higher than that attained by the prisoners on the dietaries at present in force. Our reason for arranging for a higher level of protein metabolism than is the case at present, is to have something in reserve. It may not always be possible to obtain wheat of first quality in the smaller jails; but, if Superintendents of Jails insist on having clean wheat, even though it may contain a small proportion of barley, the results obtained will be quite up to what we have calculated for. We have not taken the protein content of wheat so high as it would be in a really first class sample and, as just mentioned, we have more than 1 grm. of nitrogen per man daily in reserve. Those precautions will do more than cover any defects in the food-stuffs likely to be met with, if the inspection of the food-materials be properly carried out.

The dietaries we propose are superior in every respect to even the best of those now in use, and very much superior to all but Diet E of the Jail Code.

We have no hesitation in stating that a trial will prove them to be absolutely satisfactory.

As we have already pointed out, experience has shown that none of the present dietaries, except Diet E, are of any use in the feeding of prisoners, and that Superintendents are accustomed to devise nutritive mixtures, somewhat similar to our Diet II series, in order to make use of cereals other than wheat. We have standardised their efforts and shown exactly what combinations of wheat and other cereals with pulse will provide for practically identical degrees of protein metabolism, and thus, as far as possible, ensure that the dietaries are all of equal value.

We have considered the different food-materials very carefully and have tried to arrange the dietaries to suit their peculiarities. We do not consider that there should be any excuse, once these dietaries are introduced, for the almost complete neglect of all the cereals except wheat that obtains at the present time. For although at present the Jail Code permits Superintendents to combine any two of the different dietaries, by giving half of each, the dietaries derived in this manner are as little satisfactory as the originals. In serial No. 13 we give observations carried out on perhaps the best of the diets so derivable; the results are not very promising. Indeed it could hardly be otherwise, for, except in the combinations $\frac{A+G}{2}$ and $\frac{A+H}{2}$, the amount of wheat is too low in proportion to the other cereals and pulses.

The combinations we have suggested are those that appear to us the most suitable, but it will be quite a simple matter for Superintendents to work out for themselves the protein value and degree of protein absorption obtainable with other combinations, from the table we give showing the nitrogen content and nitrogen absorption per chittack of food-material on pages 145 and 146.

By introducing the diets we suggest as the scales for the jails of the United Provinces, a much greater use can be made of the cereals, barley, makka, juar, bajra and marua, than has hitherto been the case. We have seen that these food-materials are very extensively cultivated and largely used by the inhabitants of the Province; there is no reason why they should not be made use of in the jails also. All we have done is to suggest the proper method of doing it. The following table, supplied through the kindness of the Director of Land Records and Agriculture of the United Provinces, gives some idea of the extent to which the several food crops are cultivated : —

Name of Crop.	Percentages of total cropped area.		
	1905-06.	1906-07.	1907-08.
Juar	6	6	7
Bajra	5	5	6
Maize	5	5	6
Rice	17	17	14
Wheat	15	16	14
Barley	10	10	12
Small millets, marua, etc.	5	4	7
Gram	12	13	9
Arhar	4	4	5
Urid	3	2	3

It is evident, therefore, by limiting the jail dietaries to wheat, gram and arhar, as is practically the case at present, sufficient advantage is not taken of the food-materials at hand to vary the prison fare, and break the monotony of the same diet from month to month.

Besides making the dietaries inside the prison walls much superior to what the same classes would live on outside, it deprives the prisoners of food-materials which are very palatable and of which they are very fond.

Thus : —

(1) " Bajra is an article of diet much esteemed in some parts of India. It is eaten in the form of cakes and porridge in the United

Provinces and Bombay. Boiled with milk it forms a light and pleasant meal for invalids."

(2) "Juar is one of the most important of the food crops of India; from it are prepared bread, porridge and other food preparations."

(3) "Marua is much used by the poorer classes in Western India, usually in the form of porridge. It is considered to be practically wholesome and digestible."

(4) "Barley. The Hindus employ barley in the dietary of the sick. It is chiefly used in the form of *sattu* or powder of the parched grain."

Judging from inquiries we have made, wheat is the food of the higher and middle classes and a luxury to the poorer. In times of scarcity or famine, when wheat, gram and juar are practically the same in price, wheat is eaten largely by the people, but in ordinary times bajra and juar are the principal food-materials of the poorer classes and small cultivator.

Makka or maize is also largely used as a food-material. Barley and marua not to so great an extent as the other cereals. Arhar dal is the favourite form of pulse, and a small amount is partaken of daily.

It is, therefore, only right and fair to the prisoners that these secondary food-materials, bajra, juar, makka, barley and marua, should not be denied them. While they are not suitable to be used alone, when given along with wheat, in the manner we have indicated in the diets suggested, they are exceedingly useful in varying the monotony of the wheat diet, and in providing, food-materials to which the great mass of the prisoners are accustomed.

In the framing of the dietaries proposed, we have always borne in mind the importance of lowering the excessive amount of carbohydrates and decreasing as much as possible, the caloric value of the present dietaries. While we have not succeeded to the extent we should like, the proposed scales show on the average a considerable diminution under these headings as compared with the dietaries at present in force. It is hopeless, however, to attempt to reduce the calories per kilo of body-weight to anything approaching the limits allowed Europeans, except by a radical change in the whole type of the dietaries. As we have already pointed out, the carbohydrate element and the heat value could be suitably decreased by a large addition to the amount of pulse at the expense of the cereals. This we consider a most reprehensible method of attaining our object, as, besides the effect of large quantities of dal in causing intestinal irritation and diarrhœa, it is contrary to the customs of the people.

So far as we can gather, from extensive enquiries both in Bengal and in the United Provinces, it is only inside the walls of the jails that evidence can be obtained of dal ever being consumed in the quantities to be found in the

dietaries of the jails of Bengal and the United Provinces. The only other way of reducing the carbohydrates and heat value of the dietaries would be to change from a vegetarian to a mixed type of alimentation.

Practical considerations of expense put such a suggestion out of court, besides which, it is unnecessary.

The dietaries we have suggested are all that could be desired from a protein absorption standpoint, and while a mixed diet of animal and vegetable foods would permit of a great reduction of the carbohydrates and heat value, without decreasing the protein metabolism, it is open to the same objection as an increase in the pulse, *viz.*, it is contrary to the customs of the people.

We shall, therefore, have to rest satisfied with the reduction that has been found possible in the suggested scales.

The only other point, with regard to the proposed dietaries that we can think of as likely to form a basis for criticism, is the total quantities in actual weight of the diets.

Reference to the extract from the Jail Code at the beginning of Chapter I will show the present dietaries to be so arranged that each weighs 18 chittacks, including vegetables. The maximum weight of any of the proposed diets is 17 chittacks, and the minimum 15½ chittacks; the most nutritious diet, of the eight suggested, being the one with the lowest weight. As we have intimated, we consider two pounds by weight of uncooked food-materials amply sufficient, when cooked, to ensure the necessary feelings of comfort and satisfaction that accompany a hearty meal. As the absorption from the suggested diets is in every instance considerably higher than with the present dietaries, it will be evident that the reduction in weight of the diets is brought about by getting rid of materials in the food-stuffs that are not absorbed and which, by their presence in the bowel, only tend to increase putrefaction and fermentation. That the weight we have mentioned is sufficient is shown by the fact that we never had any complaints from prisoners who were on diets of this and even lower weights. The weight of the dietaries of the people outside the jails averaged, so far as we could gather, 12 to 13 chittacks.

In connection with what we have said regarding the neglect of makka, maize, or Indian corn as a food for human consumption in the jails of the United Provinces, we would point out that in America and in Italy it forms the principal food for the majority of the rural population.[1] In 1900 one-third of all the land under cultivation in the United States was devoted to maize. The Americans have devised many different preparations, of which the most important are the different forms of meal, granulated corn meal, hominy, pop corn, etc. Many different methods of cooking are made use of;

[1] Food Value of Corn and Corn Products. By C. D. Woods, D.Sc., U. S. Dept. of Agr. Bull. No. 298.

for the most part corn breads are of the unleavened or flat bread type, and are granular rather than porous. They are usually baked in thin loaves or cakes, the meal being mixed with water or milk and baked in the ashes of the fireplace, or on a heated stone or blade of a hoe held over the coals. The method of baking often gives rise to special terms for the bread, as hoecakes, ashcakes or corndodgers, Johnnycake, etc.

The famous Boston brown bread is usually made with corn meal, rye and whole-wheat flour, and is cooked by steam in small loaves in tightly covered tins.

The digestibility of foods made from corn has been investigated. Harcourt states that 74 per cent. of the protein and 99 per cent. of the carbohydrates of corn-meal mush are digested.

From experiments at the Marine Experiment Station the digestibility of corn-meal mush would appear to be: —

> Protein 73 per cent., carbohydrates 98 per cent., and available energy 93 per cent.

From further work on the digestibility of corn bread of different sorts carried out at the Marine Experiment Station, the results indicate that the protein of corn is slightly less thoroughly digested than that of wheat; but the difference is too slight to be of much practical consequence.[1]

"There are all sorts of popular notions about the effect of corn on the body. Thus one occasionally hears it said that it is indigestible and unfit for persons of weak digestion." "It is frequently spoken of as a good winter food, but as too 'heating' or 'heating to the blood' for summer. Just what these expressions mean it is not easy to say. Carefully conducted experiments have shown that as a rule the consumption and ingestion of carbohydrates and fats do not materially increase the output of the body-heat, but that protein does cause an increase in the amount radiated or otherwise given off from the body. Corn is not a typical protein food, as its protein content is not over 10 per cent., so it would hardly cause an appreciable increase in the output of heat from the body as compared with wheat or other common foods also supplying the different classes of nutrients in reasonable proportions. Corn is rich in fat and carbohydrates. Fat is known to protect the body from extremes of temperature, and so, it may be that corn has been spoken of as a heating food, particularly valuable in the winter diet, on account of its fat-producing properties.

"In this connection it is interesting to note that corn has always been a more important food-stuff in the Southern United States, Mexico and the Mediterranean regions than in the corresponding northern regions, even where

[1] Our experiments on the relative value of wheat and maize in Bengal Jails lead us to the same conclusion. Scientific Memoirs, No. 37.

it is a common market commodity, and this would certainly indicate that there can be no reason for supposing that cold weather is more appropriate for the use of corn foods than warm. The most reasonable deduction from the available data is that the way corn dishes are prepared and cooked, and the foods with which they are combined are more important factors than climate in regulating the use of these foods, and that, rightly used, corn bread and other corn dishes are wholesome at all seasons. That it is wholesome and well-suited to its numerous uses as a food product is abundantly proved by its long-continued use under a great variety of circumstances and conditions, and the high opinion in which it has always been held. Scientific investigations have abundantly justified the popular conclusions on the subject." [1]

The Cost of the Present Dietaries.

As the prices of food-grains vary considerably from year to year and even in different periods of the same year, it is difficult to work out even approximately an average of the cost of the feeding of prisoners that is likely to be near the mark. However, it is not necessary for our purpose that we should get the absolute cost per head, all we want, in comparing the expense entailed in feeding the prisoners on the present dietaries and on the suggested scales, is to take an average price of the different food-stuffs and work out the relative difference in the cost of the two sets of dietaries.

The following table gives the weekly price current of the food-grains in Allahabad for the week ending 9th November 1910 :—

	Rate per rupee in seers.			
	1st Class.		2nd Class.	
	Seers.	Chittacks.	Seers.	Chittacks.
Wheat	8	8	9	...
Barley	15	8	16	8
Gram	14	...	14	8
Arhar	14	...	15	...
Juar	20	...	21	..
Bajra	17	...	17	8
Urid	12	...	13	...
Rice	6	8	7	...

i.e., 8 seers 8 chittacks of 1st class wheat can be bought for one rupee
(16 chittacks equal 1 seer.)

[1] Woods. *loc. cit.*

The first step is to find out the cost of the present dietaries on the above basis.

We have found that Diet E is used for nine months in the year and a mixture of other diets for the remaining three months.

Cost of Diet E.

Wheat 11½ chittacks	1·27777 annas.
Gram 2½ „	0·17241 anna.
Arhar 1 chittack	0·06666 „
	1·51684 annas per man daily.

Therefore, for 275 days would be 26·0706 Rupees.

Cost of a mixture of other diets for 90 days.

The mixture of other diets work out to be—

Wheat 8 chittacks	0·88888 anna.
Juar or Bajra 5 chittacks	0·26974 „
Arhar 1½ chittacks	0·10000 „
Urid ½ chittack	0·03845 „
	1·29707 annas.

Therefore, for 90 days would be 7·2960 Rupees.

Therefore, the average cost of feeding the prisoners in the jails of the United Provinces, on the above rates for food-stuffs, is 33·3666 Rupees per man yearly.

The Cost of the Suggested Dietaries.

It is even more difficult to work out the cost of the proposed scales as the prices of makka and marua are unknown.

However, by taking the average of the prices of juar, bajra and barley for makka and marua we shall not be far wrong.

Diet I (*a*) and I (*b*) should not be in use for more than six months in the year.

Diet 1 (*a*) Wheat, 1st quality . . .	1·23530 annas.
Arhar	0·14285 anna.
	1·37815 annas per man daily.

Therefore, for 3 months would be 7·8382 Rupees.

Diet I (*b*)	Wheat, 1st quality . . .	1·23530 annas.
	Gram	0·10344 anna.
	Arhar	0·07142 „
		1·41016 annas per man daily.

Therefore, for 3 months would be 8·0202 Rupees.

Diet II series may be taken as represented by .	Wheat .	8 chittacks.
	2nd cereal .	4 „
	Arhar . .	2 „

Diet II Series.

Wheat, 1st quality	0·94117 anna.
2nd cereal	0·21818 „
Arhar	0·14285 „
	1·30220 annas per man daily.

Therefore, for six months would be 14·8939 Rupees. That is, on the current price list given, the cost of the present dietaries works out at 33·3666 Rupees per man yearly; while the cost of the suggested scales works out to be 30·7523 Rupees yearly. So that, on this basis there would be a saving with the suggested scales of 2·6143 Rupees per man yearly. That is, we are able to give the prisoners distinctly better types of dietaries, containing first quality of wheat and far less monotonous than the present scales, without increasing the cost to the State. We have already shown how very much superior the proposed dietaries are to those at present in force; except in the case of Diet E there is no comparison between them. Yet, by arranging the several food-stuffs available in a judicious manner it has been found possible to reduce the cost of the dieting of the prisoners (taking the average number of prisoners in the United Provinces at 38,000) by upwards of a lakh of rupees per year.

We need hardly say that we worked out the proposed new dietary scales entirely from a physiological standpoint, fixing the quantities of the several food-stuffs according to the nitrogenous requirements of the prisoner and that the question of cost was not taken into consideration at all.

CHAPTER VIII.

Some side-issues of the investigation.

I.—The Quantity of Salt given in the Jail Dietaries of the United Provinces.

In our work on the salt question of the Bengal Jail Dietaries we made numerous observations on the effects of the large salt intake peculiar to those dietaries,[1] and on the effects of varying the quantity of salt of the diet on the body-weight, the excretion of NaCl in the urine and fæces and the relationship of the quantity of urine secreted to the amount of salt consumed. The results obtained showed conclusively that the quantity of salt provided in the dietaries of prisoners in Bengal jails is far too great; its only physiological effect being to increase the body-weight by water-logging of the tissues, to create thirst and cause diuresis. With regard to other effects, pathological in nature we brought forward evidence to show that an excessive intake of salt was neither to the welfare of the body in health nor in disease.

Our observations made it apparent that an addition of 10 to 12 grms. of NaCl in the daily diet provides all that is necessary for physiological requirements, and that anything beyond that amount only causes a retention of fluids within the body with a fictitious advance in body-weight, thirs and diuresis. We suggested that the quantity of salt in the Bengal Jail Dietaries —about 30 grms.—should be decreased by one-half.

How does this recommendation compare with the facts as made evident in the dietaries of prisoners in the jails of the United Provinces?

The quantity of salt sanctioned in the Jail Code for the dietaries of the jails of the United Provinces is 150 grains or about 10 grms. per man daily, an amount practically identical with what we found to be amply sufficient for the requirements of Bengal prisoners. In all our investigations in the different jails of the United Provinces this quantity—10 grms. per man daily—was almost invariably given and never once have we had any complaints from the prisoners of its insufficiency. It may, therefore, be accepted that the quantity of salt we recommend for addition to the dietaries of Bengal jails is more than is really required, as was stated by us at the time of writing the report, and that 10 grms. of NaCl per man daily is quite sufficient for the jail dietaries of the United Provinces and Bengal.

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[1] Scientific Memoirs, No. 37, Chapter IV.

II.—The Average Quantity of Urine Secreted by prisoners in the Jails of the United Provinces.

We found in Bengal jails that the average quantity of urine passed was consistently high; that the amount depended on the salt content of the dietaries, and that rice appeared to exert a diuretic influence, this influence being more marked with Burma than with country rice.

In cold weather the average amount of urine passed on the full Bengal jail dietaries was quite up to 2,000 c. c. per man daily.

What is the average secretion of urine by prisoners in the United Provinces on the full dietaries ?

(*a*) On Diet E.

Wheat	11½ chittacks.	10 grms. NaCl added to diet.
Gram	2½ „	
Arhar	1 chittack.	
Vegetables	3 chittacks.	

Agra	10	men	observed	for	10	days	passed	90,900	c. c.
Naini	10	„	„	„	10	„	„	209,690	c. c.
Benares	6	„	„	„	7	„	„	63,850	c. c.
„	5	„	„	„	5	„	„	37,470	c. c.

Therefore an average of 1,505 c. c. of urine was passed per man daily.

(*b*) Diet E.

On Diet E, when the wheat was reduced to 10 chittacks.

i.e., Wheat	10 chittacks	10 grms. NaCl added to diet.
Gram	2½ „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Agra	10	men	observed	for	10	days	passed	87,650	c.c.
Naini	10	„	„	„	6	„	„	132,530	c.c.
Benares	6	„	„	„	7	„	„	75,060	c.c.
„	6	„	„	„	7	„	„	48,700	c.c.
„	5	„	„	„	5	„	„	50,220	c.c.
„	5	„	„	„	5	„	„	27,930	c.c.

Therefore an average of 1,435 c.c. of urine was passed per man daily.

(c) Diet 1/2 (E+F).

Juar	5½ chittacks	10 grms. NaCl added to diet.
Wheat	5¾ „	
Gram	2¾ „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Agra . . 10 men observed for 30 days passed 307,570 c.c.

Therefore an average of **1,205** c.c. of urine was passed per man daily.

(d) Diet A.

Wheat	11 chittacks	10 grms. NaCl added to diet.
Barley	3 „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Mainpuri Jail . . 10 men observed for 19 days passed 186,650 c.c.

Therefore an average of 982 c.c. urine was passed per man daily.

(e) Diet G.

Wheat	3 chittacks	10 grms. NaCl added to diet.
Barley	11 „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Mainpuri Jail . . 10 men observed for 19 days passed 212,320 c.c. of urine.

Therefore an average of **1,117** c.c. of urine was passed per man daily.

(f) Diet B.

Bajra	12 chittacks	10 grms. NaCl added to diet.
Urid	2 „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Naini Jail . . . 10 men observed for 10 days passed 151,650 c.c.

Therefore an average of **1,516** c.c. of urine was passed per man daily.

(*g*) On other diets in which the total quantity of dry food-materials made up 18 chittacks, the amount sanctioned by the Jail Code.

(i)

Bajra	8 chittacks	10 grms. NaCl added to diet.
Wheat	4 „	
Urid	2 „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Naini Jail . . 10 men observed for 6 days passed 89,710 c.c.

(ii)

Bajra	4 chittacks	10 grms. NaCl added to diet.
Wheat	9 „	
Arhar	2 „	
Vegetables	3 „	

Naini Jail . . 10 men observed for 6 days passed 122,080 c.c.

(iii)

Wheat	6 chittacks	10 grms. NaCl added to diet.
Bajra	7 „	
Arhar	2 „	
Vegetables	3 „	

Naini Jail . . 10 men observed for 6 days passed 93,750 c.c.

(iv)

Wheat	5 chittacks	10 grms. NaCl added to diet.
Juar	8 „	
Arhar	2 „	
Vegetables	3 „	

Benares Jail . . 5 men observed for 7 days passed 42,310 c.c.

Therefore an average of 1,618 c.c. of urine was passed per man daily when these diets were given.

By summing up these results and taking the average, we obtain a fairly true measure of the quantity of urine passed by the prisoners of the United Provinces on the dietaries sanctioned for use. None of these observations were made in the hot weather; those in Agra Jail were carried out in October while the weather was still comparatively hot, otherwise the average quantity of urine found to be excreted may be taken to refer to the cold weather.

The quantity works out to be :—

(*a*) 401,910 c. c. of urine divided by 267
(*b*) 422,090 c. c. „ „ „ „ 294
(*c*) 307,570 c. c. „ „ „ „ 300
(*d*) 186,650 c. c. „ „ „ „ 190
(*e*) 212,320 c. c. „ „ „ „ 190
(*f*) 151,650 c. c. „ „ „ „ 100
(*g*) 347,850 c. c. „ „ „ „ 215

That is 2,030,040 c. c. „ „ „ „ 1,256

which means 1,305 c. c. of urine per man daily.

This is a very much smaller amount than that found for the quantity of urine passed by prisoners in Bengal jails, which we have seen to average over 2,000 c.c. per man daily. We have no doubt the difference can be satisfactorily explained by the much lower salt content of the dietaries of the United Provinces and the entire absence of rice.

III.—The Excretion of Chlorides in the Urine.

The quantity of chlorides present in the urine was estimated in all cases where collection and examination of the urine was carried out. As a rule the amount of NaCl given, in addition to that already present in the food-stuffs constituting the diet, was 10 grms. per man daily: in a few cases, however, 15 grms. of salt were added.

(*a*) The Quantity of Chlorides excreted in the Urine when 15 grms. of NaCl were added to the Dietary.

Agra Jail.

10 men	observed	for	9	days	excreted	1,126·4 grms.	NaCl.
10 „	„	„	10	„	„	1,212·7 „	„
10 „	„	„	10	„	„	1,183·5 „	„
10 „	„	„	10	„	„	1,197·5 „	„
10 „	„	„	10	„	„	1,219·6 „	„
10 „	„	„	10	„	„	1,089·4 „	„
10 „	„	„	10	„	„	1,152·0 „	„
10 „	„	„	10	„	„	1,235·5 „	„

Therefore, an average of 11·92 grms. of chlorides was excreted per man daily, or 79·5 per cent. of the added chlorides of the diet.

(*b*) The Quantity of Chlorides excreted in the Urine when 10 grms. of NaCl were added to the Diet.

(*i*) Mainpuri Jail.

10 men	observed	for	6	days	excreted	464·6 grms.	NaCl.
10 „	„	„	6	„	„	498·7 „	„
10 „	„	„	7	„	„	602·7 „	„
10 „	„	„	6	„	„	521·4 „	„
10 „	„	„	6	„	„	511·8 „	„
10 „	„	„	7	„	„	548·5 „	„

Therefore, an average of 8·28 grms. of chlorides, or 82·8 per cent. of the added chlorides of the diet, appears in the urine.

(*ii*) Benares Jail.

6	men	observed	for	7	days	excreted	356·0 grms.
6	„	„	„	6	„	„	305·0 „
6	„	„	„	7	„	„	348·1 „
5	„	„	„	6	„	„	268·6 „
6	„	„	„	7	„	„	369·0 „
5	„	„	„	6	„	„	256·8 „
5	„	„	„	6	„	„	262·8 „
6	„	„	„	7	„	„	387·1 „
6	„	„	„	6	„	„	311·7 „
5	„	„	„	7	„	„	305·8 „
5	„	„	„	6	„	„	270·3 „

Therefore, an average of 8·71 grms. of chlorides, or 87·1 per cent. of the added chlorides of the diet, appears in the urine.

By taking the average of these results we obtain the average amount of chlorides passed when 10 grms. of NaCl are added to the dietaries.

(*i*) Mainpuri Jail . 10 men observed for 38 days passed 3,147·7 grms.
(*ii*) Benares Jail . 5 men observed for 79 days passed 3,441·2 „

Therefore, 6,588·9 divided by 775 gives the average amount of chlorides excreted per man daily=8·502 grms., or 85·02 per cent. of the added chlorides of the diet.

Comparison of these results with those obtained with Bengali prisoner shows a lower percentage of the added chlorides of the diets absorbed.

Thus—with 15 grms. NaCl (about) added 88 per cent. appeared in the urine.
„ 10 „ „ „ „ 90 „ „ „ „ „ „

The explanation of these differences is to be found in the quality of the salt in use in the two provinces: the figures for the salt intake in Bengal were corrected to show the nett amount of chlorides given with the food, while those of the United Provinces show the gross amount.

IV.—The Quantity of Fæces passed by Prisoners on the United Provinces Jail Dietaries.

(*a*) Diet E.

Wheat	11½ chittacks.
Gram	2½ „
Arhar	1 chittack.
Vegetables	3 chittacks.

[1] Scientific Memoirs, No. 37, Chapter IV.

Agra	Jail	.	10	men	observed	for	10	days	passed	109·50 lbs.
,,	,,	.	5	,,	,,	,,	7	,,	,,	60·45 ,,
Naini	,,	.	10	,,	,,	,,	10	,,	,,	167·50 ,,
Benares	,,	.	6	,,	,,	,,	6	,,	,,	38·45 ,,
,,	,,	.	5	,,	,,	,,	6	,,	,,	38·72 ,,
Naini	,,	.	5	,,	,,	,,	5	,,	,,	28·04 ,,
Lucknow	,,	.	5	,,	,,	,,	5	,,	,,	35·25 ,,

} Ordinary Jail sample of wheat.

Therefore, 477·91 divided by 351 gives the average quantity of fæces per man daily=1·36 lbs., or 21·76 ozs.

(*b*) **Diet E.**

Wheat	11½	chittacks.
Gram	2½	,,
Arhar	1	chittack.
Vegetables	3	chittacks.

} First quality of wheat.

Benares Jail.—Five men observed for 7 days passed 34·65 lbs.=0·99 lb., or 15·84 ozs. per man daily.

The contrast between these two results brings out very clearly the great difference a good quality of wheat makes in the amount of non-digestible residue that has to be dealt with by the intestinal tract.

(*c*) **Diet 1/2 (E+F).**

Wheat	5¾	chittacks.
Juar	5½	,,
Gram	2¾	,,
Arhar	1	chittack.
Vegetables	3	chittacks.

Ten prisoners observed for 10 days passed 108·75 lbs., or 1·087 lbs.=17·39 ozs. per man daily.

(*d*) **Diet A.**

Wheat	11	chittacks.
Barley	3	,,
Arhar	1	chittack.
Vegetables	3	chittacks.

Ten prisoners under observation for 19 days passed 220·8 lbs.=1·162 lbs., or 18·59 ozs. per man daily.

(*e*) Diet G.

Barley	11 chittacks.
Wheat	3 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten prisoners under observation for 19 days passed 241·30 lbs.=1·27 lbs., or 20·32 ozs. per man daily.

(*f*) Diet A.

Bajra	12 chittacks.
Urid	2 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten prisoners under observation for 10 days passed 132·5 lbs.=1·325 lbs., or 21·20 ozs. per man daily.

(*g*) Diet F.

Juar	11 chittacks.
Urid	3 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Five prisoners under observation for five days passed 48·10 lbs.=1·924 lbs., or 30·78 ozs. per man daily.

(*h*) Other diets in which the total quantity of the dry food-materials made up 18 chittacks, the amount sanctioned by the Jail Code.

(*i*)	Bajra	8 chittacks.
	Wheat	4 „
	Urid	2 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Ten prisoners under observation for 6 days passed 76·0 lbs.=1·26 lbs., or 20·26 ozs. per man daily.

(*ii*)	Bajra	4 chittacks.
	Wheat	9 „
	Arhar	2 „
	Vegetables	3 „

Ten prisoners under observation for 6 days passed 93·07 lbs.=1·55 lbs., or 24·80 ozs. per man daily.

(*iii*)	Bajra	7 chittacks.
	Wheat	6 „
	Arhar	2 „
	Vegetables	3 „

Ten prisoners under observation for 6 days passed 86·58 lbs.=1·44 lbs., or 22·98 ozs. per man daily.

(*iv*)	Wheat	11½ chittacks.
	Gram	3½ „
	Vegetables	3 „

Four prisoners under observation for 6 days passed 36·9 lbs.=1·496 lbs., or 23·93 ozs. per man daily.

(*v*)	Wheat	8 chittacks.
	Barley	6 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Five prisoners under observation for 5 days passed 34·28 lbs.=1·371 lbs., or 21·93 ozs. per man daily.

(*vi*)	Wheat	6 chittacks.
	Juar	7 „
	Arhar	2 „
	Vegetables	3 „

Five prisoners under observation for 5 days passed 34·90 lbs.=1·396 lbs., or 22·33 ozs. per man daily.

(*vii*)	Wheat	3 chittacks.
	Barley	11 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Five prisoners under observation for 6 days passed 38·1 lbs.=1·27 lbs., or 20·32 ozs. per man daily.

By summing up these results and taking the average we obtain a fairly true measure of the weight of fresh fæces passed by the prisoners of the United Provinces when on the full dietaries sanctioned.

The amount works out to be:—

(*a*)	477·91	lbs. fæces	divided by	351
(*c*)	108·75	„ „	„ „	100
(*d*)	220·80	„ „	„ „	190
(*e*)	241·30	„ „	„ „	190
(*f*)	132·50	„ „	„ „	100
(*g*)	48·10	„ „	„ „	25
(*h*)	398·83	„ „	„ „	284

which means 1·313 lbs., or 21·00 ozs. of fæces per man daily.

The average weight of fæces passed on the jail dietaries of the United Provinces is 21 ozs., an amount greatly in excess of that excreted by Europeans, and higher even than the weight of fæces passed by the Bengali or Behari.

V.—The effect of an Increase or Decrease of the Wheat in the Dietaries on the quantity of Fresh Fæces passed.

Under heading IV (*a*) we saw that with Diet E an average of 21·76 ozs. of fæces was passed per man daily; what is the effect of increasing and decreasing the quantity of wheat in the diet on the weight of fresh fæces excreted?

(*a*) *Increasing the Wheat.*

Wheat	13 chittacks	Ordinary jail sample of wheat.
Gram	2½ „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Agra Jail	10 men	under observation	for	10	days	passed	.	121·85	lbs.
„ „	5 „	„	„	„	„	7 „	„	. 67·46	„

Therefore, on an average 1·40 lbs., or 22·43 ozs. of moist fæces are passed per man daily on this diet. This result should be contrasted with the average of the first two observations, given under IV (*a*), on the same prisoners in Agra Jail. Thus:—

	Diet E.+ 1½ chittacks of wheat.	Diet E.
Agra Jail	22·43 ozs. of fæces passed.	20·12 ozs. fæces passed.

So that, an increase of 1½ chittacks, or about 3 ozs., of wheat in the diet causes an increase of 2·31 ozs. in the weight of the corresponding fæces excreted.

(*b*) *Decreasing the Wheat.*

Wheat	10	chittacks.
Gram	2½	„
Arhar	1	chittack
Vegetables	3	chittacks

} Ordinary jail sample of wheat.

Agra	Jail	10	men	under	observation	for	6	days	passed	55·50 lbs.
„	„	5	„	„	„	„	7	„	„	47·42 „
Naini	„	10	„	„	„	„	6	„	„	89·00 „
Benares	„	6	„	„	„	„	6	„	„	38·75 „
„	„	5	„	„	„	„	6	„	„	38·13 „
„	„	5	„	„	„	„	6	„	„	35·80 „

Therefore, 301·60 divided by 251 gives the average weight of moist fæces per man daily, equals 1·213 lbs., or 19·40 ozs., passed on this diet.

Contrasting this result with the average weight of moist fæces passed on Diet E, we get :—

Diet E.	Diet E. lessened by 1½ chittacks of wheat.
21·76 lbs. of fæces passed per man daily.	19·40 lbs. of fæces passed per man daily.

So that, a decrease of 1½ chittacks of wheat, about 3 ozs., causes a decrease of 2·36 ozs. in the weight of the corresponding fæces excreted.

We may conclude, therefore, that with ordinary jail wheat the weight of the moist fæces passed, with Diet E and its modifications, varies directly with the quantity of wheat in the diet.

What is the effect of reducing the wheat by 1½ chittacks when first quality of wheat is used ?

Wheat	10	chittacks
Gram	2½	„
Arhar	1	chittack
Vegetables	3	chittacks

} First quality of wheat.

Benares	Jail	5	men	under	observation	for	6	days	passed	27·31 lbs.
„	„	5	„	„	„	„	6	„	„	26·20 „

Therefore, on an average 0·891 lb., or 14·25 ozs., is excreted per man daily. This result should be contrasted with that shown under IV (*b*) where Diet E with first quality of wheat was in use. Thus :—

Diet E.	Diet E. lessened by 1½ chittacks of wheat.
15·84 ozs. of fæces passed per man daily.	14·25 ozs. of fæces passed per man daily.

So that, a decrease of 1½ chittacks, or about 3 ozs., of first class wheat causes a decrease of 1·59 ozs. in the weight of the corresponding fæces excreted. With ordinary jail wheat the lowering under the same condition was 2·36 ozs. of fæces, again showing how very much less waste there is with a good class of wheat than with inferior samples.

Numerous other observations on the weight of moist fæces passed on various diets were carried out, in fact weighments of the fæces were done in every observation made on prisoners. The results show :—

(*i*) The large mass of fæces passed with diets composed of the food-stuffs in use in the United Provinces. The average weight of moist fæces excreted by prisoners on the full jail dietaries is 21 ozs. per man daily.

(*ii*) Decrease or increase in any one of the food-stuffs entering into the composition of a diet is accompanied by a decrease or increase in the weight of the corresponding fæces.

(*iii*) When first quality of wheat is made use of—the dietaries being similar in all other respects—the weight of moist fæces excreted is considerably smaller than when the ordinary jail sample of wheat is given. For Diet E the comparison is as follows :—

Benares Jail.

Ordinary jail wheat	. . .	average weight of fæces 18·72 ozs.
First quality wheat	. . .	„ „ „ „ 15·84 „

(*iv*) The maximum average weight of fæces excreted in any of the periods of observation took place when the total quantity of pulses entering into the dietaries was high. See IV (*g*) and (*h*) (*iv*) also VI (*i*) (*xxii*) and (*xxiv*) of this chapter.

VI.—The Average Amount of Nitrogen excreted in the Fæces of Prisoners when on the Full Jail Dietaries.

(*a*) Diet E.

Wheat	11½ chittacks	Ordinary jail sample of wheat.
Gram	2½ „	
Arhar	1 chittack	
Vegetables	3 chittacks	

							Weight of fæces.		Nitrogen of fæces.	
Agra	Jail	10 men	observed for	10	days	passed	109·50	lbs. containing	596·90	grms.
„	„	5 „	„	7	„	„	60·45	„ „	196·04	„
Naini	„	10 „	„	10	„	„	167·50	„ „	505·40	„
Benares	„	6 „	„	6	„	„	38·45	„ „	196·66	„
„	„	5 „	„	6	„	„	38·72	„ „	166·14	„
Naini	„	5 „	„	5	„	„	28·04	„ „	124·74	„
Lucknow	„	5 „	„	5	„	„	35·25	„ „	128·58	„

Therefore a total of 477·91 lbs. of moist fæces showed 1,914·46 grms. of nitrogen.

The average amount of nitrogen in the fæces, therefore, works out to be 0·88 per cent.

(*b*) Diet E.

Wheat	11½ chittacks	First quality of wheat.
Gram	2½ „	
Arhar	1 chittack	
Vegetables	3 chittacks	

Benares Jail—5 men observed for 7 days passed 34·65 lbs. of fæces containing 151·27 grms. of nitrogen, which works out to be 0·96 per cent.

(*c*) Diet 1/2 (E+F.)

Wheat	5¾ chittacks.
Juar	5½ „
Gram	2¾ „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten men observed for 10 days passed 108·75 lbs. of fæces containing 588·57 grms. of nitrogen, which works out to be 1·19 per cent.

(*d*) Diet A.

Wheat	11 chittacks.
Barley	3 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten prisoners under observation for 6 days passed 68·3 lbs. of fæces containing 317·64 grms. of nitrogen, which works out to be 1·02 per cent.

(*e*) **Diet G.**

Barley	11 chittacks.
Wheat	3 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten prisoners under observation for 6 days passed 74·3 lbs. of fæces containing 305·24 grms. of nitrogen, which works out to be 0·905 per cent.

(*f*) **Diet A.**

Bajra	12 chittacks.
Urid	2 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Ten prisoners under observation for 10 days passed 132·50 lbs. of fæces containing 645·08 grms. of nitrogen, which works out to be 1·07 per cent.

(*g*) **Diet F.**

Juar	11 chittacks.
Urid	3 „
Arhar	1 chittack.
Vegetables	3 chittacks.

Five prisoners under observation for 5 days passed 48·10 lbs. of fæces containing 181·89 grms. of nitrogen, which works out to be 0·83 per cent.

(*h*) Other diets in which the total quantity of dry food-materials made up 18 chittacks—the official amount—show the following results:—

i.	Bajra	8 chittacks.
	Wheat	4 „
	Urid	2 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Ten prisoners under observation for 6 days passed 76·00 lbs. of fæces containing 343·08 grms. of nitrogen, which works out to be 0·99 per cent.

ii.	Bajra	4 chittacks.
	Wheat	9 „
	Arhar	2 „
	Vegetables	3 „

Ten prisoners under observation for 5 days passed 77·57 lbs. of fæces containing 245·47 grms. of nitrogen, which works out to be 0·69 per cent.

iii.	Bajra	7 chittacks.
	Wheat	6 „
	Arhar	2 „
	Vegetables	3 „

Ten prisoners under observation for 5 days passed 72·08 lbs. of fæces containing 262·93 grms. of nitrogen, which works out to be 0·80 per cent.

iv.	Wheat	11½ chittacks.
	Gram	3½ „
	Vegetables	3 „

Four prisoners under observation for 6 days passed 35·90 lbs. of fæces containing 119·33 grms. of nitrogen, which works out to be 0·73 per cent.

v.	Wheat	8 chittacks.
	Barley	6 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Five prisoners under observation for 5 days passed 34·28 lbs. of fæces containing 116·58 grms. of nitrogen, which works out to be 0·75 per cent.

vi.	Wheat	6 chittacks.
	Juar	7 „
	Arhar	2 „
	Vegetables	3 „

Five prisoners under observation for 5 days passed 34·90 lbs. of fæces containing 134·75 grms. of nitrogen, which works out to be 0·85 per cent.

vii.	Wheat	3 chittacks.
	Barley	11 „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Five prisoners under observation for 6 days passed 38·10 lbs. of fæces containing 156·55 grms. of nitrogen, which works out to be 0·90 per cent.

By summing up these results and taking the average we obtain a fairly true measure of the average amount of nitrogen contained in the fæces excreted by prisoners of the United Provinces on the full jail dietaries sanctioned. It will be evident from the results shown in detail above, that the percentage of nitrogen in the fæces varies within very narrow limits whatever the diet may be. We called attention to this in the work on the Bengal Jail Dietaries, in which also the variations of the percentage of nitrogen in the fæces were small, even with absolutely dissimilar dietaries.

How do the results of the investigations work out ?

(*a*)	477·91	lbs.	of	moist	fæces	contain	1914·46	grms.	nitrogen.
(*b*)	34·65	„	„	„	„	„	151·27	„	„
(*c*)	108·75	„	„	„	„	„	588·57	„	„
(*d*)	63·30	„	„	„	„	„	317·64	„	„
(*e*)	74·30	„	„	„	„	„	305·24	„	„
(*f*)	132·50	„	„	„	„	„	645·08	„	„
(*g*)	48·10	„	„	„	„	„	181·89	„	„
(*h*) *i.*	76·00	„	„	„	„	„	343·08	„	„
(*h*) *ii.*	77·57	„	„	„	„	„	245·47	„	„
(*h*) *iii.*	72·08	„	„	„	„	„	262·93	„	„
(*h*) *iv.*	35·90	„	„	„	„	„	119·33	„	„
(*h*) *v.*	34·28	„	„	„	„	„	116·58	„	„
(*h*) *vi.*	34·90	„	„	„	„	„	134·75	„	„
(*h*) *vii.*	38·10	„	„	„	„	„	156·55	„	„
Therefore	1,308·34	„	„	„	„	„	5,482·84	„	„

Therefore 1 lb. moist fæces contains 4·19 grms. nitrogen.
i.e., 453·76 grms. „ „ 4·19 „ „

Therefore, the average percentage of nitrogen in the fæces works out to be 0·92 per cent.

As the average weight of fæces passed by prisoners on the full jail dietaries is 21 ozs., $\frac{21 \times 4 \cdot 19}{16}$ gives the average amount of nitrogen excreted by prisoners in the fæces per man daily: this works out to be 5·4993 grms. of nitrogen.

We have shown in Chapter III, when dealing with the average absorption from the jail dietaries, that the average protein content of the dietaries was 16·7292 grms. of nitrogen, of which 11·286 grms. are absorbed, *i.e.*, 5·4432 grms. nitrogen on the average are excreted in the fæces — a figure approximately identical with that determined above, *viz.*, 5·4993 grms.

Numerous other observations were made on the amount of nitrogen passed in the fæces when diets were given in which the several quantities of the

different food-stuffs made up totals other than 18 chittacks. We shall give some of the results and see what deductions can be drawn from them.

(*i*) Other diets in which the total quantity of food-materials was either greater or less than 18 chittacks.

Five prisoners under observation for five days.

i.	Wheat	11½	chittacks.
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces — 27·38 lbs. containing 94·57 grms. of nitrogen.

Four prisoners under observation for five days.

ii.	Wheat	11½	chittacks.
	Arhar	3	„
	Vegetables	3	„

Total quantity of fæces — 31·47 lbs. containing 83·26 grms. of nitrogen.

Five prisoners under observation for six days.

iii.	Wheat	11½	chittacks.
	Gram	2	„
	Vegetables	3	„

Total quantity of fæces—29·85 lbs. containing 125·14 grms. of nitrogen.

Five prisoners under observation for five days.

iv.	Wheat	14	chittacks.
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—29·69 lbs. containing 110·37 grms. of nitrogen.

Five prisoners under observation for five days.

v.	Wheat	8	chittacks.
	Barley	5	„
	Arhar	1	chittack.
	Vegetables	3	chittacks.

Total quantity of fæces—27·98 lbs. containing 108·25 grms. of nitrogen.

Five prisoners under observation for six days.

vi.	Wheat	3	chittacks.
	Barley	9	„
	Arhar	1	chittack.
	Vegetables	3	chittacks.

Total quantity of fæces—39·44 lbs. containing 143·17 grms. of nitrogen.

Five prisoners under observation for five days.

vii.	Wheat	7	chittacks.
	Bajra	7	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—39·50 lbs. containing 149·52 grms. of nitrogen.

Five prisoners under observation for two days and four prisoners for three days.

viii.	Wheat	8	chittacks.
	Bajra	4	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—28·70 lbs. containing 112·67 grms. of nitrogen.

Five prisoners under observation for five days.

ix.	Wheat	8	chittacks.
	Bajra	6	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—38·62 lbs. containing 148·12 grms. of nitrogen.

Five prisoners under observation for five days.

x.	Wheat	5	chittacks.
	Bajra	7	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—29·20 lbs. containing 131·99 grms. of nitrogen.

Five prisoners under observation for six days.

xi.	Wheat	8	chittacks.
	Bajra	4	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—34·21 lbs. containing 131·91 grms. of nitrogen.

Five prisoners under observation for six days.

xii.	Wheat	10½	chittacks.
	Gram	2½	„
	Arhar	1	chittack.
	Vegetables	3	chittacks.

Total quantity of fæces—35·80 lbs. containing 138·52 grms. of nitrogen.

Five prisoners under observation for six days.

xiii.	Wheat	10½	chittacks.
	Gram	2½	„
	Arhar	1	chittack.
	Vegetables	3	chittacks.

Total quantity of fæces—26·20 lbs. containing 111·78 grms. of nitrogen.

Five prisoners under observation for six days.

xiv.	Wheat	10½	chittacks.
	Gram	2½	„
	Arhar	1	chittack.
	Vegetables	3	chittacks.

Total amount of fæces—38·13 lbs. containing 151·59 grms. of nitrogen.

Five prisoners under observation for six days.

xv.	Wheat	8	chittacks.
	Bajra	4	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—26·85 lbs. containing 119·07 grms. of nitrogen.

Six prisoners under observation for five days.

xvi.	Wheat	8	chittacks.
	Juar	4	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—23·77 lbs. containing 104·57 grms. of nitrogen.

Five prisoners under observation for six days.

xvii.	Wheat	8	chittacks.
	Bajra	6	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—26·89 lbs. containing 143·29 grms. of nitrogen.

Five prisoners under observation for six days.

xviii.	Wheat	3	chittacks.
	Juar	8	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—17·41 lbs. containing 115·45 grms. of nitrogen.

Five prisoners under observation for five days.

xix.	Wheat	8	chittacks.
	Juar	6	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—19·47 lbs. containing 101·24 grms. of nitrogen.

Five prisoners under observation for six days.

xx.	Wheat	8	chittacks.
	Barley	6	„
	Arhar	2	„
	Vegetables	3	„

Total quantity of fæces—33·90 lbs. containing 151·67 grms. of nitrogen.

Six prisoners under observation for twelve days.

xxi.	Wheat	11½ chittacks.
	Arhar	2 „
	Vegetables	3 „

Total quantity of fæces—46·35 lbs. containing 224·54 grms. of nitrogen.

Five prisoners under observation for four days.

xxii.	Wheat	5 chittacks.
	Juar	7 „
	Urid	2 „
	Gram	2 „
	Vegetables	3 „

Total quantity of fæces—39·15 lbs. containing 145·50 grms. of nitrogen.

Five prisoners under observation for four days.

xxiii.	Wheat	11½ chittacks.
	Arhar	2 „
	Vegetables	3 „

Total quantity of fæces—23·43 lbs. containing 100·50 grms. of nitrogen.

Five prisoners under observation for four days.

xxiv.	Wheat	5 chittacks.
	Juar	5 „
	Urid	2 „
	Gram	2 „
	Vegetables	3 „

Total quantity of fæces—35·41 lbs. containing 132·24 grms. of nitrogen.

Five prisoners under observation for seven days.

xxv.	Wheat	11½ chittacks.
	Gram	1½ „
	Arhar	1 chittack.
	Vegetables	3 chittacks.

Total quantity of fæces—54·06 lbs. containing 196·04 grms. of nitrogen.

Five prisoners under observation for seven days.

xxvi. Wheat . . . . . 13½ chittacks.
Gram . . . . . 2½ „
Arhar . . . . . 1 chittack.
Vegetables . . . . . 3 chittacks.

Total quantity of fæces—67·46 lbs. containing 230·57 grms. of nitrogen.

Five prisoners under observation for seven days.

xxvii. Wheat . . . . . 10½ chittacks.
Gram . . . . . 2½ „
Arhar . . . . . 1 chittack.
Vegetables . . . . . 3 chittacks.

Total quantity of fæces—47·42 lbs. containing 189·83 grms. of nitrogen.

We have in these 27 observations sufficient material from which to obtain a fairly true measure of the average weight of fæces passed per man daily, the average amount of nitrogen they contain and the percentage of nitrogen in the fæces, when diets are made use of in which the total weight of the dry food-stuffs is either greater or less than the amount sanctioned by the Jail Code.

The results are as follows :—

	Factor for division (number of prisoners for number of days.)	Total weight of fæces. lbs.	Total nitrogen of fæces. grms.
i	25	27·38	94·57
ii	20	31·47	83·26
iii	30	29·85	125·14
iv	25	29·69	110·37
v	25	27·98	108·25
vi	30	39·44	143·17
vii	25	39·50	149 52
viii	22	28·70	112·67
ix	25	38·62	148·12
x	25	29·20	131·99
xi	30	34·21	131·91
xii	30	35·80	138·52

	Factor for division (number of prisoners for number of days).	Total weight of fæces. lbs.	Total nitrogen of fæces. grms.
xiii	30	26·20	111·78
xiv	30	38·13	151·59
xv	30	26·85	119·07
xvi	30	23·77	104·57
xvii	30	26·89	143·29
xviii	30	17·41	115·45
xix	25	19·47	101·24
xx	30	33·90	151·67
xxi	72	46·35	224·54
xxii	20	39·15	145·50
xxiii	20	23·43	100·50
xxiv	20	35·41	132·24
xxv	35	54·06	196·04
xxvi	35	67·46	230·57
xxvii	35	47·42	189·83

Adding these results together we get :—

Factor for division.	Total weight of fæces. lbs.	Total nitrogen of fæces. grms.
784	917·74	3,695·37

Therefore, (1) The average weight of fæces passed is 1·17 lbs. or 18·72 ozs. per man daily.

(2) The average quantity of nitrogen in the fæces is 4·70 grms. per man daily.

(3) The average percentage of nitrogen in the fæces works out to be 0·88 per cent.

Contrasting these results with those obtained when the full jail dietaries — 18 chittacks of dry food-materials—were given, we find the average weight of the moist fæces passed, and the average amount of nitrogen contained in the

fæces are both lower: this is what would be expected as in the great majority of these 27 observations the total weight of the dietaries was decreased.

On the other hand, the percentage of nitrogen in the fæces is practically identical with that shown by the fæces when the prisoners were on the full jail dietaries, *viz.*, 0·88 and 0·92 per cent. respectively.

This again affords further proof of the constancy of the relative amount of nitrogen in the fæces, however different the dietaries may be.

CHAPTER IX.

The Relationship of Food to Physical Development.

In our report of the work on Bengal Jail Dietaries we discussed at some length the problems in nutrition raised by Chittenden. We are exceedingly interested in the question of the degree of nitrogenous interchange essential for the proper well-being of the body, and on the effects of a low level of protein metabolism. We have therefore tried to take advantage of every opportunity this work on the food-stuffs of India affords of obtaining evidence of the effect of food on the physical condition of the different races and tribes with whom we have had to deal.

From the evidence we were able to collect in Bengal from observations on students, servants, prisoners, inhabitants of Lower Bengal, Beharis, and on the different hill-tribes around Darjeeling, we arrived at the conclusion that an intimate connection exists between the physical development and general well-being of a people and the level of nitrogenous interchange they attain, and that diet is a powerful factor in determining the position of a tribe or race in the scale of mankind. We found that, as was the case with the inhabitants of the plains in Bengal so with the hill-tribes around Darjeeling, variations in the amount of nitrogenous metabolism appear to be the determining factor of the several causes that go to relegate, fix and maintain the position of a people, tribe or race in the category of men. We showed with regard to the scale of relative physical development, vigour and general muscularity, that the position of the different races of Bengal was easily fixed. We gave the following list[1] showing the position of the different races or tribes and also indicating the average levels of nitrogenous metabolism attained :—

		Nitrogen metabolised per kilo of body-weight.
i.	Bhutias,—Nepalese Bhutias	0·42 grm. (highly animal diet).
	Tibetan and Bhotan	0·35 „
	Sikkim Bhutias	0·25 „
ii.	Nepalese	0·18 to 0·25 grm.
iii.	Beharis	0·145 grm.
iv.	Bengalis and Ooriyas	0·116 „

We have no intention of going any deeper into the discussion of Chittenden's views at present : suffice it to say, our work on the different races and tribes of the provinces of India that we have investigated has afforded ample evidence to force us to the conclusion that, in the growth and development of an individual, tribe or race, parsimony in nutrition is, physiologically, a false economy.

[1] Scientific Memoirs, No. 37, page 222.

We shall now endeavour to bring forward the evidence we have been able to obtain amongst the inhabitants of the United Provinces of the rôle played by diet in the general development and well-being of the people.

This we shall take up under two headings :—

I.—The evidence afforded by prisoners in the United Provinces.

II.—The evidence afforded by information collected from regimental medical officers and from other sources.

I.—The Evidence afforded by Prisoners in the United Provinces.

We have shown that the jail dietaries of the United Provinces permit of an average nitrogenous interchange of 11·286 grms. of nitrogen per man daily. Contrasted with the prisoners in Orissa, Lower Bengal or Behar, this level of protein metabolism is very much superior. In Orissa and Lower Bengal we found that the average absorption was about 7·5 grms. and in Behar 9·5 grms. of nitrogen per man daily. The jail dietaries of the United Provinces are therefore very much superior to those in force in Bengal.

It would be a mistake, however, to suppose that the average dietaries of the mass of the population outside the jails is on a par with the jail dietaries, or that the inhabitants of the province attained on the average a level of nitrogenous metabolism of 11·286 grms. of nitrogen per man daily. Such a supposition would be far from the truth.

This level of protein metabolism amongst prisoners is mainly due to the large quantity of wheat given in their dietaries.

The poorer classes and small cultivator cannot afford to live on wheat to anything like this extent; bajra, juar, makka, marua and barley are all made use of in different parts of the Province as the staple food-stuffs, wheat, as the principal item of the diet, being largely a luxury. It follows, therefore, that the degree of nitrogenous interchange possible must be considerably lower amongst the inhabitants in general than obtains with prisoners. Just what level of protein metabolism the average inhabitant of the United Provinces attains we are unable to state definitely; but, from the knowledge of the percentages of absorption possible from the several food-materials, and from diets investigated, similar in type to those in general use, it may be accepted that an average of 9 to 9·5 grms. of nitrogen is metabolised daily. This amount is decidedly superior to what was found for the level of nitrogenous metabolism with the Bengali and Behari, *viz.*, 6 grms. daily in the case of the Bengali and 8 grms. daily in the case of the Behari.

The following note from the Imperial Gazetteer of India affords some additional information on the food of the inhabitants of the United Provinces:

"The two principal meals are taken in the morning and evening and consist of unleavened cakes called chapatis, made of flour of wheat, barley or millet (bajra, juar or marua), according to the means of the consumer. With these are eaten vegetables and pulse cooked with clarified butter (*ghi*). Rice is often substituted in the central and eastern districts, but is less used in the West, except by the well-to-do. Sweet cakes are eaten in the middle of the day or early afternoon and often at the evening meal. Mutton and beef are universally used by the Musalmans, and mutton by the high-caste Hindus of the Saiva sects, and by the lower caste Hindus when they can afford it. The poorest classes make their principal meal in the evening, and in the morning eat some parched grain or gram in the western districts, barley or rice in the eastern and maize everywhere. Mangoes and, where found, the mahua flower (*Bassia latifolia*), form an important addition in the hot season. Potatoes are commonly eaten in the hills, and their use is spreading in the plains."

"In 1901, out of total population of 47,691,782, Hindus numbered 40,691,818, or more than 85 per cent., and Musalmans 6,731,034, or 14 per cent. The Musalmans dwelling in the Provinces are more prolific than the Hindus, and longer lived, partly because, on the whole they are better off, enjoy a more liberal diet, form a large proportion of the total in the more prosperous western districts, do not practise child-marriage largely and allow re-marriage of widows."

What evidence is there that the effect of the higher level of protein metabolism amongst the inhabitants of the United Provinces is to the advantage of their physical development and general well-being?

From observations on representatives of the inhabitants within the prisons where investigations were carried out, we would have no hesitation in saying that, compared with the same classes in the jails of Lower Bengal, on the average the inhabitants of the United Provinces are on a distinctly higher plane of physical development. The general muscularity of the body is decidedly better and their capabilities for labour are greater. They are smarter on their feet, more brisk and more alive to the incidents of every-day life, and they do not present such slackness and tonelessness as one is accustomed to observe in the people of Lower Bengal.

The body-weight, and what is in reality of most importance, the actual quantity of protoplasmic tissues, is also on a higher scale of development.

The average weight of the inhabitants of Bengal, including Behar, has been estimated at 50·0 kilos.[1]

From observations on weighments of over 2,000 prisoners in the jails of the United Provinces, the average body-weight of the prisoner may be accepted

[1] Scientific Memoirs, No. 34.

to be about 54 to 56 kilos. Taking the average body-weight at 55 kilos and the protein metabolism at 9·25 grms. of nitrogen per man daily, this would mean a daily interchange of 0·168 grms. of nitrogen per kilo of body-weight, as compared with 0·116 grm. per kilo of body-weight in the case of the Bengali and Ooriya, and 0·145 grm. with the Behari.

The prisoners of the United Provinces with their average level of 11·286 grms. of nitrogenous metabolism show an interchange of 0·205 grm. of nitrogen per kilo of body-weight, compared with 0·151 grm. of nitrogen in Bengali prisoners and 0·173 grm. of nitrogen in Behari prisoners per kilo of body-weight.

It may, therefore, be accepted, so far as the evidence afforded by prisoners goes, that on an average they attain a protein metabolism of 0·205 grm. of nitrogen per kilo of body-weight (a quantity very much in excess of what Chittenden would consider sufficient, *viz.*, 0·12 grm.) ; that the average body-weight may be taken at 55 kilos.; that the average level of nitrogenous metabolism attained by the general population of the provinces is about 0·168 grm. of nitrogen per kilo of body-weight; that the people of the United Provinces are better fed, better developed physically, more capable of hard work, hardier and more alive than the average inhabitant of Bengal of the same class.

The United Provinces contain several of the different tribes or races that have been found suitable for warlike purposes. Thus, there are the Brahmins, Rajputs, Jats, etc., and others who present the necessary characteristics and qualities that go to make up the soldier. We shall have more to say on these races under our next heading; all we need say at present is that the evidence would clearly point to a close relationship between the level of protein interchange and the degree of physical development to be expected. Practically all other explanations, that have been put forward to account for the poor physique of the races on a low level of protein metabolism, can be successfully met by a comparison of the inhabitants of the United Provinces with the people of Bengal. Early marriages, actinic rays of the sun, sexual excesses, etc., are, to all intents and purposes, the same in the United Provinces as in Bengal. Climate does differ in the two provinces to some extent: in Bengal the temperature is lower and humidity higher than in the United Provinces; but, while the climate of the United Provinces is on the whole perhaps less depressing than that of Bengal, the difference is not such as to be able to account for the well recognised characteristics of the Bengali and those of the fighting races of the plains of Agra and Oudh. We have nothing to add to what has already been pointed out[1] with regard to this except to affirm again our strong belief in the efficacy of a liberal diet, and more particularly a sufficiently liberal degree

[1] Scientific Memoirs, No. 37, page 210.

of nitrogenous interchange, in the formation and development of those attributes and qualities of mind and body that are alike the pride of the soldier and the envy of inferior races.

II.—The Evidence afforded by information collected from Regimental Medical Officers, and from other sources.

No explanation other than diet would appear to meet the conditions met with in a comparison of the inhabitants of the provinces of Bengal and the United Provinces living in the great plain that extends from the sea north-west to the boundaries of Oudh. The manners, customs, religion, caste rules, etc., are much the same amongst the same sects throughout: the climate except for a greater humidity in Lower Bengal for a few months in the year does not markedly differ in the United Provinces and Behar, and early marriages, except among Musalmans, are practised all over this area. Yet, we find that Bengal provides no recruiting areas for the Indian Army, whilst even in the United Provinces only certain tribes are recruited from; other tribes, living in the same place, subject to the same customs and caste rules, being passed over in the selection of soldiers.

We know that there may be instances in which non-selection is to be ascribed to causes other than the non-possession of the necessary manly qualities and martial spirit, and in which, therefore, the fact of a tribe or race not forming a source for the supply of fighting material may be no true criterion of the physical development and the general manliness of its individual members. On the other hand, it will be admitted that as the material at present selected from is exceedingly good, there must have been some reason why those particular tribes were preferred in the first instance.

Accepting, therefore, that the tribes recruited from for the Indian Army are superior in physique, courage, boldness and general manly vigour to the ordinary population of the United Provinces, it appeared to us a question of some importance to ascertain, if possible, the dietaries on which this superiority has been attained.

For this purpose we collected information under the following headings from the medical officers of over twenty regiments:—

i. The food-stuffs made use of by the different classes or races represented in the regiment.

ii. Information as to the food-stuffs made use of by these representatives when in their own homes, *i.e.*, before becoming soldiers.

iii. Whether animal food in any form, milk, eggs, fish, etc., enters into the dietaries of the different tribes in their own homes.

iv. Information as to the physical development, height, chest girth and body-weight.

We shall take up the information obtained in this way under the headings of the several races or tribes represented in the different regiments—

1. Jats.[1]

The food-stuffs made use of by the Jats in their homes during the important early years of life when growth is taking place are :—

Bread made from wheat, bajra, juar and other cereals. Rabri, prepared by mixing bajra with buttermilk. Dals and vegetables of all kinds. Rice, seldom eaten in any form. Milk, curd and *ghi* (clarified butter) are used to a fair extent as the majority of the families from which recruits would be obtained are able to keep their own cows and buffaloes.

Animal food enters to a very limited extent into the diet of the Jats in their homes. Mutton, goat's flesh and eggs are partaken of very sparingly—on the average once or twice per month, and usually on the occasion of some religious festival.

Sugarcane and sweets are eaten fairly extensively.

This is practically a vegetarian diet which, on an average, would permit of a protein metabolism very little higher than that of the general population were it not for the considerable quantities of milk and curd that the Jats consume. The nitrogen of milk is easy of absorption and, taken in fair quantities, would raise very considerably the level of nitrogenous interchange.

In the early years of life up to when they enlist, milk forms an important item of their dietary, whereas, the amount of animal flesh or even eggs partaken of is small. After enlisting the men continue to drink milk, even though they have to purchase and pay for it out of their own pockets.

We may conclude, therefore, that the Jat is on a somewhat higher level of protein metabolism than the average inhabitant of the United Provinces, and being better off will be able to afford a more liberal amount of wheat in his diet.

Physical development.—The Jats on the whole are fairly well developed. Height 68 to 69 inches, chest-girth 34 to 36 inches, the average weight one officer returns at 150 lbs., but this is probably too high.

The medical officer of a Jat regiment states that as a class they appear to pick up any infection easily, and that their alimentary canal is readily disturbed

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[1] For information on the Jats we are indebted to Captains H. P. Cook, I.M.S., A. H. Howlett, I.M.S., and C. L. Sowdenlet, I.M.S.

by changes in diet. Their soldierly instincts are undoubtedly great; and though not so sturdy as some of the other races of northern India, their claim to be regarded as good fighting material is valid.[1]

2. Brahmins[2] recruited from the United Provinces.

The food-stuffs of the Brahmins.—Children are suckled for the first three years of life; milk of the cow, buffalo and goat is also given in addition. *Ghi* (clarified butter) is added to the milk from the age of 18 months; rice or bread from two years and dal after three years of age.

Meat is never given before the age of seven or eight.

Adults in their own homes.—Bread made from flour of the different cereals. Different dals. Sometimes rice in small quantities.

Milk is taken very freely.

Meat is taken very rarely, *i.e.*, two or three times in a year. Many men never touch meat and only very few take it oftener than once in a fortnight.

Eggs are never eaten and fish very rarely.

Fresh vegetables are taken every day or every second day, taking the place of dal as a rule.

This diet is therefore very much the same as that of the Jats and would allow of a similar degree of protein interchange. The Brahmins belong to the highest caste amongst Hindus and are, as a rule, considerably better off than the average inhabitant, so that, besides being able to provide themselves with plenty of milk, a large proportion of their bread is made from wheat flour, the inferior cereals, bajra, juar and other millets forming a smaller proportion of the diet.

On the whole we may accept it that the dietaries of the Jats and Brahmins are pretty much the same and of practically equal value in their protein element.

Physical development.—The medical officer of a class Brahmin Regiment writes:—"On enlistment the average height of recruits is 69½ inches and the average chest measurement (full expansion) 36·7 inches. The men, however, are not very muscular until they have been through a course in the gymnasium when they put on muscle rather better than the men of most regiments. By the time they have finished their preliminary training their physique is very good.

"In some respects their stamina does not seem to be very good, but I am inclined to think this is more the result of their habits than of their diet. A large amount of debility seems to be brought about by the men, when fatigued

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[1] The Fighting Races of India: Bonarjee.

[2] For information on the Brahmin we are indebted to Captain R. C. Macwalters, I.M.S.

going without food rather than cook it, as their caste rules require them to do. On manœuvres, when the weaklings are left behind, the men of this regiment stand hard work very well."

3. Rajputs.[1]

Rajputs are roughly divided into two classes, Eastern and Western. The former are chiefly drawn from Cawnpore, Allahabad, Benares and Lucknow districts, while the latter and better physical type of Rajput is drawn from Agra, Delhi, Rohtak, Hissar, Nabba, Patiala and Gurgaon districts. These two sections differ somewhat in their caste rules and food; the Western Rajput tending to be more elastic in observance of caste obligations, and hence more amenable to changes of diet when directed. In some Rajput regiments the Eastern Rajput is no longer recruited. A great portion of the Rajputs of the Punjab has been converted to Mahomedanism, and have thereby lost their distinctive character as Rajputs. Some of the best Punjabi Mahomedan clans being nothing more than Rajput Mahomedans.

Food-stuffs eaten in their homes—(*i*) *Eastern Rajputs.*—Wheat and other cereals, juar, bajra, etc. Rice is made use of to some extent.

Gram and other dals: Makka or maize and vegetables. Milk and *ghi* are taken freely.

Little meat or animal food is eaten by the Eastern Rajput, although all Rajputs are meat eaters when the cost can be afforded.

(*ii*) *Western Rajputs.*—Wheat, maize, and other cereals. Dal and vegetables of all kinds, also milk and *ghi* are freely partaken of.

Flesh of goat, mutton, chickens, fish and eggs are all made use of by the Western Rajput in varying quantities. Roughly 75 per cent. of this class partake of meat.

The dieting of the Western and better type of Rajput is therefore decidedly superior in assimilable protein to that of the Eastern Rajput. The effect of even a small amount of animal food per day makes a considerable difference in the level of nitrogenous interchange. It is significant in connection with this that one medical officer speaks of the Western as superior to the Eastern Rajput, while another medical officer of a Rajput regiment volunteers the important information that Eastern Rajputs are no longer recruited for the particular regiment to which he belongs.

The dietary of the Western Rajput is probably superior in the amount of assimilable protein it offers to either that of Jat or Brahmin.

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[1] For information on the Rajput we are indebted to Captains W. L. Watson, I.M.S., and D. C. Graham, I.M.S.

Physical development.—Generally speaking the physique of the Rajput may be taken to be average in type—

Height (average)	67 to 68 inches.
Chest-girth	34 to 37·5 „
Weight	147 to 154 lbs.

The farther west a Rajput is, the less he is under Brahminical influence ; the closer to Benares, the more priest-ridden, superstitious and punctilious is he in regard to his religious customs. All Rajputs will eat flesh (except of course forbidden flesh), and do not object to the flesh of wild boar, though he will have nothing to do with the common domestic pig. There is no doubt that the western Rajputs make far better soldiers than the Eastern : one reason advanced is that the former is far more pure-blooded than the latter ; on the other hand, the differences in diet and in the consumption of animal food by the two classes would appear to be a more important determining factor. "The Rajput makes a good soldier, but is easily depressed and knocked out of tune by failure and defeat. He is willing to go anywhere and do anything when things are well, but the dogged pertinacity, the spirit which refuses to recognise defeat, the capacity to arise above failure, are not his." (Bonarjee : The Fighting Races of India.)

The Rajputs are of peculiar interest from our standpoint as they are the modern non-Brahminical and more or less pure-blooded representatives of the early Aryan immigrants into India. The history of these people would seem to show that the closer the adherence to original caste rules has been the less in evidence at the present time are those qualities essential to the soldier. As we have seen with regard to Hindu Rajputs, the eastern branch, or those most under priestly influence, and therefore conforming more closely to the Brahmins in manners and customs, is regarded as considerably inferior for recruiting purposes to the western branch in which the caste rules are much more lax and in which animal food materials are more freely partaken of. This divergence from the original Hindu manners and customs is still greater in thsse portions of the Rajputs which have been converted to Mahomedanism.

Thus the Sials are a tribe or caste of Rajput Mahomedans who were converted to Islam in the 14th century. They are a fine race, brave, self-respecting, and hardy, with considerable pride of race. Physically, they are big and strong men, rather rude and rough in their demeanour. The Tiwanas, Gondals, Chibbs, Kharrals, and Bhattis are all of the Rajput stock. These tribes offer splendid material for those regiments that enlist Panjabi Mahomedans.

4. Dogras.[1]

The Dogras are a Rajput race of Highlanders, preponderatingly Hindu by religion. Their country is most fertile yielding large quantities of various cereals and fruits. The hills abound in cattle of good breed, and agriculture is carried on with intelligence and care, producing large crops.

Ethnologically the Dogras are of the same blood and race as the Rajputs of the plains : the main difference between the Dogras and the Rajputs of the Punjab and Rajputana is that the former have a keener sense of national pride and a higher feeling of national integrity. They are on the whole of finer physique than the plain Rajputs. Dogra recruits, caught young, while there is yet time for good physical development to take place, soon fill out with liberal feeding, drill, and systematic exercises. The general appearance of a Dogra regiment leaves nothing to be desired. "Their steady and resolute, though not showy, courage, renders them very reliable soldiers, and they justly enjoy the reputation of being among the best fighting material to be found in the country." [Bonarjee.]

Food-stuffs.—The Dogra eats wheat and other cereals, particularly maize and bajra. The men from Jammu and Kashmir eat rice also.

Dal of all kinds and vegetables are used.

Milk, *ghi*, curds, buttermilk are partaken of freely.

The strictest sects do not, but many Dogras do, eat fowls and eggs. If they can afford it, Dogras eat meat frequently and game when obtainable.

This diet is on the whole a fairly good one and much superior to diets of the Bengal type, or even to most of those in force in the United Provinces.

Physical development.—The Dogra amongst the great fighting races is a small man of moderate physique. Average height 67 to 68 inches. Average chest measurement 34 to 36 inches. No records of body-weight are available.

The value of the Dogra in the fighting line is well-recognised and requires no comment from us. In connection with this point, however, we might draw attention to the fairly liberal degree of nitrogenous interchange permitted by the type of dietary in use, and to the considerable proportion of animal food entering into the diet.

5. Jat Sikhs.[2]

Recruited from the "Malwa" District around the Sutlej. The Jat Sikh is mainly a wheat-eater, but supplements this with dal of all kinds and different vegetables available.

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[1] We are indebted to Captains M. J. Quirke, I.M.S., and A. Cameron, I.M.S., for information on Dogras.

[2] We are indebted to Major C. C. Wimberley, I.M.S., and Captain W. P. C. Williams, I.M.S., for information on the Jat Sikh.

Although wheat is the staple food, in their own homes they also eat bajra, maize, juar and other inferior cereals; when these form the main items, however, more milk, curd, buttermilk and *ghi* are taken in addition.

Goat's flesh, mutton, venison, pork, and occasionally hares, porcupine, etc., are all eaten when procurable, but not in large quantities.

Milk, *ghi*, curds, buttermilk are largely consumed, as all are agriculturists and peasant proprietors with buffaloes and cows in their possession.

Eggs are rarely eaten, as few of them keep fowls.

Fish is used by such men as live near rivers, but does not enter largely into their dietary.

The dietary as outlined above is distinctly of a superior type. Being agriculturists and peasant proprietors a full sufficiency of all the food-stuffs available from the land is ensured, and the addition of a free supply of milk to a fairly liberal diet in other respects, particularly in animal food, would mean a high level of protein interchange.

Physical development.—"Jat Sikhs as a class are late of development, and recruits of 18 to 19 years of age are often lanky, undeveloped looking lads. As a rule they have well shaped chests with good expansion and plenty of 'bone.' They rapidly develop into men of powerful physique under a course of drill, gymnastic, etc., with a liberal diet."

Average height	68-69 inches.
Average chest-girth	33-35 „
Average weight	140 to 150 lbs.

The Jat Sikh is admittedly a fine example of the fighting races who have earned their reputations on the Indian Frontier, or where courage, stamina and manly qualities are absolutely essential. "Taken as a whole, the Sikh is one of the finest types of man to be found in Asia. He is independent without being insolent, resolute and firm in character, remarkably free from the petty bias and prejudices which run rampant in a land of prejudices like India; respects himself and, as a consequence, commands the respect of others; is a soldier by instinct and tradition; regards cowardice as worse than crime; and with his splendid physique and well-bred ways is altogether one of the finest of Oriental races." (Bonarjee).

6. The Sikh.[1]

The two classes of Sikhs considered in this note are Labahnas and Muzbies. Their food and general habits appear to be identical.

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[1] We are indebted to Captains R. B. Seymour Sewell, I.M.S., A. Cameron, I.M.S., and W. P. C. Williams, I.M.S., for information on the Sikh.

(*i*) *The food-stuffs made use of in the Regiment.*

(*a*) *Recruits.*—All recruits are fed in one Recruit's mess. The food and quantities per recruit are as follows:—

Milk	5 chittacks equals 10·2 ozs. every day.
Ghi	2 ozs. per day.
Monday, Wednesday, Saturday	Wheat flour 12-14 chittacks. Dal „ 1½ „ Vegetables q. s.
Tuesday, Friday	Wheat flour 12-14 chittacks. Mutton 3-4 „ Dal 1½ „ Vegetables q. s.
Thursday, Sunday	Wheat flour 12-13 chittacks. Sugar 1 chittack. Ghi 1 „ Dal 1-2 chittacks. Vegetables q. s.

The vegetables are either fresh green vegetables or potatoes. In addition to above, recruits frequently purchase other delicacies out of their pay and on an average consume 16 ozs. of milk daily.

(*b*) The ordinary trained Sikh takes two meals daily—morning and evening. The ordinary articles of diet with their approximate quantities are as follows:—

Milk	16 ozs. daily.
Flour (wheat)	24 „ „
Ghi	2 „ „
Dal	4 „ „
Vegetables: Potatoes	4-6 „ „

Rice.—Six to 8 ozs. is taken occasionally as a change; when this is done less wheat flour—about 16 ozs.—is used.

Meat	16 ozs. taken two or three times a month.
Rum	3½ ozs. per man daily.

(*ii*) *The food-stuffs in use in their own homes,* i.e., *before becoming soldiers.*

(*a*) *Children.*—Children are usually breast-fed for about 2½ years. After the age of 1½ years the mother's milk is supplemented by fresh cow's milk diluted with an equal quantity of water. Towards the end of the period of suckling the child is given a morning feed of curdled milk—a sort of junket—4 ozs. daily.

(*b*) At 2½ years of age the child is weaned. He is then given four meals a day consisting of the following food-stuffs, roughly in the quantities given below :—

Milk	8 ozs. and upwards.
Curd	2 „ only at morning meal.
Wheat	8 „
Rice	4 „
Dal	2 „
Sugar	2 „
Vegetables	2 „
Ghi	1 oz.

At the age of 3 years the child begins to take meat in small quantities—usually two or three times a month.

(*c*) Young adults living in their villages take much the same food as the ordinary soldier Sikh. However, they usually drink more milk of cows, buffaloes or goats. Cows and buffalo's milk is generally boiled, goat's unboiled.

The various kinds of animal food that enter into the dietaries of the Sikhs in their own homes are :—

Commonest, goat's flesh, occasionally mutton.

Fowls are eaten, but only male fowls.

Venison, bacon, eggs, duck, pigeons, fish are all partaken of when available. The better off the family happens to be the greater is the average amount of animal food in the dietary. Beef is never made use of.

It will be evident from the above notes and from what has been said with regard to the Jat Sikh, that the splendid reputation the Sikh regiments of India have acquired has not been made on dietaries affording a low level of protein metabolism ; but, on the contrary, that the nitrogenous interchange possible from their diet scales is quite on a par with that of European soldiers. The Sikh is, perhaps, the best known outside of India of the martial tribes of the plains : it is therefore of interest to learn something of the dietary on which he lives. From all that we can discover, difference in dietary forms the one feature of importance in contrasting the manners and customs of the Sikh with other Hindu tribes, which are of little or no value in the fighting line. Even in a comparison with other Hindu tribes that are recruited from, the Sikh is admittedly second to none. We have no desire to attempt to classify or place in order of merit the different tribes we have mentioned, but, to those who have lived in India, it would be fairly evident that the Sikh is certainly a better

fighting man than most of those on whom observations have been made. We have no hesitation in saying that the dietary of the Sikh is superior to that of any of the tribes so far considered, and, failing any other explanation of his superior qualities, we must admit the determining influence of the high level of protein metabolism attained during the more important early years of life, the period in which the body framework and protoplasmic tissues are being built up.

As we have already pointed out in a comparison of the hill-tribes of Bengal,[1] we are very strongly of the opinion that physique, stamina, energy and general manly qualities are closely dependent on the degree of nitrogenous interchange possible from the dietary. We believe that climate and certain customs, such as early marriages, sexual excesses, etc., have an undoubted influence on the physical development and general well-being of the different tribes, but, where it is possible to eliminate climate and caste influences, as in a comparison of tribes living under the same condition but on different dietaries, there can be no doubt of the superiority of the physical development of those tribes whose diet is the most liberal and whose daily average of metabolised nitrogen reaches a high level. This is clearly brought to light in a study of the races and tribes inhabiting the great plains of Bengal, United Provinces and the Punjab : as an extreme case, we may take as an example the Sikh and the Behari. These races live under practically identical conditions as to caste obligations, and climate forms no great determining factor in the Sikh's favour, yet in the Sikh we obtain men of good physique and splendid fighting qualities, while in the Behari the qualifications essential for the soldier are so little in evidence that his claims for a martial life are entirely overlooked.

The Behari we found lives on a protein metabolism of 8 to 9 grms. of nitrogen, whilst the Sikh reaches a level of 12 to 14 grms. of nitrogen per man daily.

We wish for no stronger evidence than this of the effect of a high level of protein metabolism on the physical development and formation of those manly characteristics that enforce respect, and relegate a tribe or race to its proper position amongst the inhabitants of India. Having seen the results of dietaries offering varying quantities of assimilable protein on different tribes, otherwise under similar conditions, we are firmly of the opinion that the level of protein interchange advocated by Chittenden is too low, and that a liberal supply of assimilable nitrogen in the daily food is to the advantage of the individual and to the welfare of the race.

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[1] Scientific Memoirs, No. 37.

Physical development of the Sikh—

Average height	67·5 to 68·5 inches.
Average chest-girth	33·5 to 35·5 „

No records of body-weight available.

7. The Pathan.

The food of the Pathan is much the same as that given for the Sikh except that the Pathan is a much greater meat-eater than the Sikh. He will consume all forms of animal flesh given for the Sikh and will eat beef as well. In their homes animal food is taken daily.

The figures obtained would show that the Pathan is superior in physique to any of the races mentioned. His fighting qualities are too well-known to require mention by us. As in addition to their superior type of dietary the Pathan tribes belong to the hills, and have therefore the advantage of a bracing climate, we shall, for the present, avoid further details.

GENERAL SUMMARY.

This concludes our work on the jail dietaries of the United Provinces and the information we have been able to obtain on the effects of food, as exemplified in the different tribes mentioned above.

Our aim has been to determine experimentally the nutritive values of the diets at present in use in the jails of the United Provinces, and to work out the co-efficients of protein and carbohydrate absorption of the different food-materials entering into those dietaries. From the data thus obtained, we have been able to frame new dietaries, whose nutritive value depends on the degree of nitrogen absorption possible from the food-materials and not on their gross chemical composition. A series of eight such diets are given which are practically of identical nutritive values, and are, therefore, interchangeable; the particular diet in use at any stated time will depend on the season of the year and on the food-materials available. We have discussed some of the side-issues of the investigation, and shown how very great the loss of protein by the fæces is when inferior vegetable food-stuffs are made use of. The practically constant percentage of the nitrogen of the fæces, whatever the type of diet may be, is worthy of note. Lastly, from the facts we have been able to collect with regard to the inhabitants of the United Provinces and martial races of the plains, there would appear to be abundant evidence that, other things being equal, diet is the all-important factor in determining the degree of physical development and general well-being of a people, and that with a low level of nitrogenous interchange deficient stamina, morally and physically, must be expected.

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